Manufacturing British 18-Pounder High-Explosive Shells--I*

By E. A. Suverkrop

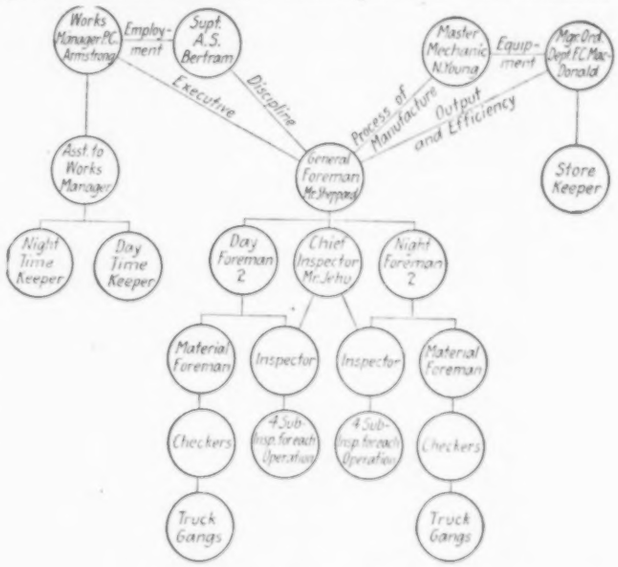
SYNOPSIS—The manufacture of this shell presents an entirely different group of problems from those encountered in the production of either the 4.5-in. high explosive or the 18-pounder shrapnel shell. The blank instead of being a hollow forging is a solid block of steel 3½ in. in diameter by 9¾ in. long. It weighs nearly 27 lb. By various machine and hand operations the weight is reduced to a little less than 15 lb.; that is to say, about 12 lb. of metal must be removed from the blank, and of this about one-half must come from the inside.

Before undertaking the manufacture of this shell the Dominion Bridge Co., Ltd., Montreal, Canada, had turned out large quantities of 18-pounder British shrapnel, which in external appearance is somewhat similar to the high-explosive shell. As a large part of the work on shrapnel had been successfully done on turret lathes the attempt was at first made to use these tools on the high-explosive shell. So a part of the shrapnel shop was commandeered and the first high-explosive shells made on the tools used for the production of shrapnel.

Perhaps the greatest handicap to manufacturing on machines which require a fair amount of intelligence is the dearth of skilled operators here in Canada; and it was soon apparent that if the required output of 4,000 shells per day was to be attained, the job would have to be reduced to simple operations on simple machines wherever possible, so that unskilled help could soon be broken in to do the work. Even the few necessary turret-lathe operations have been made so elementary that skilled operators are not required, and green hands can in a few minutes be instructed so that they will produce good work.

The working out of the system is a long story, similar to many others of a like nature with which all shopmen are familiar. It is, as it should be, the result of the combined brains and hard work of executives of the ordnance department and not any one man's guess or fiat. In Fig. 1 is shown the organization chart of the ordnance department.

The simplifying of operations, and consequent multiplying of them and of the number of tools necessary to perform them, called for more space than was available



Note - The Manager of the Ordnance Department, the Works Manager, Superintendent, and Master Mechanic are to confer and agree on all general Shop Policy.

FIG. 1. ORDNANCE ORGANIZATION CHART

in the shrapnel shop. It was therefore decided to build a new shop, to be known as the No. 2 shell shop, which should house all the machining operations on the 18-pounder high-explosive shell.

As previously stated, the required output is 4,000 shells per day of 22 working hours. Under the new system of simplified manufacturing operations, a floor area of about 42,000 sq.ft. is necessary. The building for the No. 2 shell shop is a single-story structure, chiefly of wood.

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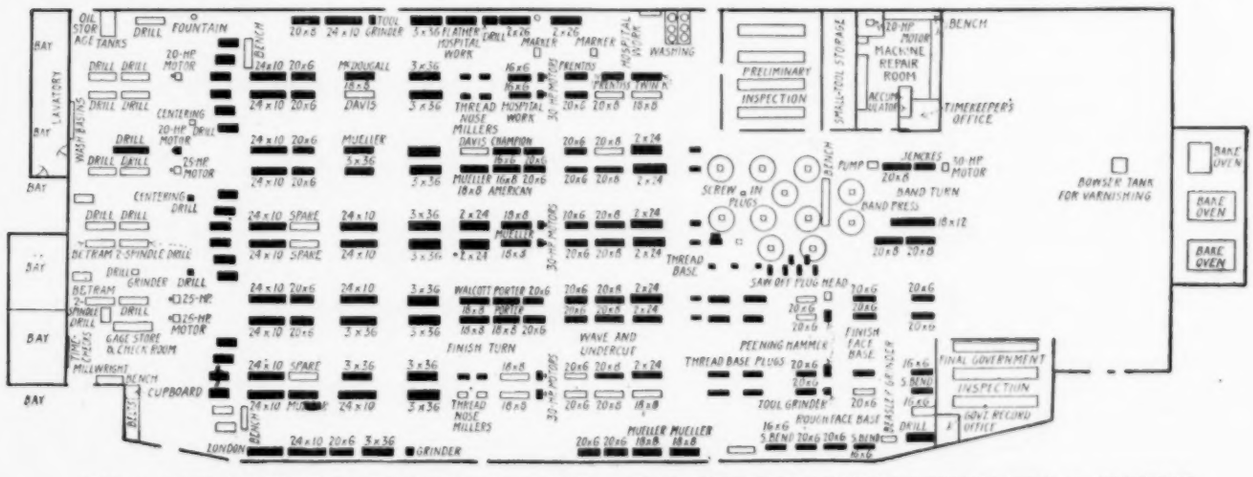


FIG. 2. LAYOUT OF MACHINERY IN NO. 2 SHELL SHOP USED FOR MANUFACTURING THE 18-POUNDER HIGH-EXPLOSIVE SHELL

It is about 120 ft. wide by 350 ft. long. There is plenty of light from the windows on the sides and ends and from numerous skylights in the roof. Structural work is of course the regular work of this concern, but even at that the building of a shop 120 by 350 ft. in 17 days is some stunt.

Elsewhere in this issue are shown progress views showing the building 2 hr. and 45 min. after work was begun on it; one taken 7 days later; one 14 days later and one 21 days later.

Before taking up the shop and manufacture a few words on the system, which has resulted in the practical elimination of scrap, may not be out of place.

By referring to Fig. 1 it will be noted that the general foreman is in direct charge of the shop. Under him are two day and two night foremen. These have a head inspector and material foreman for the day and night shifts. Over the head inspectors is a chief inspector. Below each head inspector and under his general supervision are four inspectors for each operation. All questions concerning inspection are referred to the head inspector, or to the chief inspector as a final court of appeal. The inspectors examine the work on the completion of each operation, and that which passes inspection is stamped with a symbol.

Besides inspecting the work in its various stages, the inspectors must examine the shape and depth of the centers in the work; and also, to insure good work, they must inspect the centers on the lathes and see that they are kept in good condition.

The duty of the material foreman is to keep the machines supplied with work, to keep track of the work as each operation is completed and to see that it is kept moving as soon as it has passed inspection.

In order to fulfill these duties the material foreman has a staff of checkers for each operation. They follow the inspectors on each operation and mark up to each operator's credit the number of pieces passed and stamped by the inspector for that operation. The checkers turn in their reports to the general foreman so that he can inform himself of any shortage or surplus of work from any of the operations. He can then find the reason and correct it, or if necessary, change over a machine which is ahead with production and set it up for the operation which is in arrears.

Also under the material foreman but more directly under the checkers are the truck gangs, whose duty it is to truck the work from operation to operation after it has been tallied on the checkers' forms.

In Fig. 2 is shown the floor plan of the No. 2 shell shop with the layout of the machines, and in Table 1 is given the layout of work and the make and capacity of machines in the shop. It would perhaps be as well to read these two together, for apart from the descriptions of individual operations, they really tell the whole story of the manufacture of the 18-pounder high-explosive shell.

The rough blanks enter the No. 2 shop at the left and travel thereafter in a straight line to completion at the other end of the shop. With a very few exceptions only, and these due to misadventure, there is no back-tracking of the work after it once enters the door.

As previously stated, the blanks are cut from bar stock and are therefore solid. The steel from which they are made must have a yield point of at least 42,500 lb., tensile strength between 78,400 lb. and 87,360 lb., elongation of 20 per cent., carbon content between 0.45 and 0.55 per cent.; nickel under 0.50, manganese between 0.4 and 1, sulphur and phosphorus under 0.05 per cent. Having

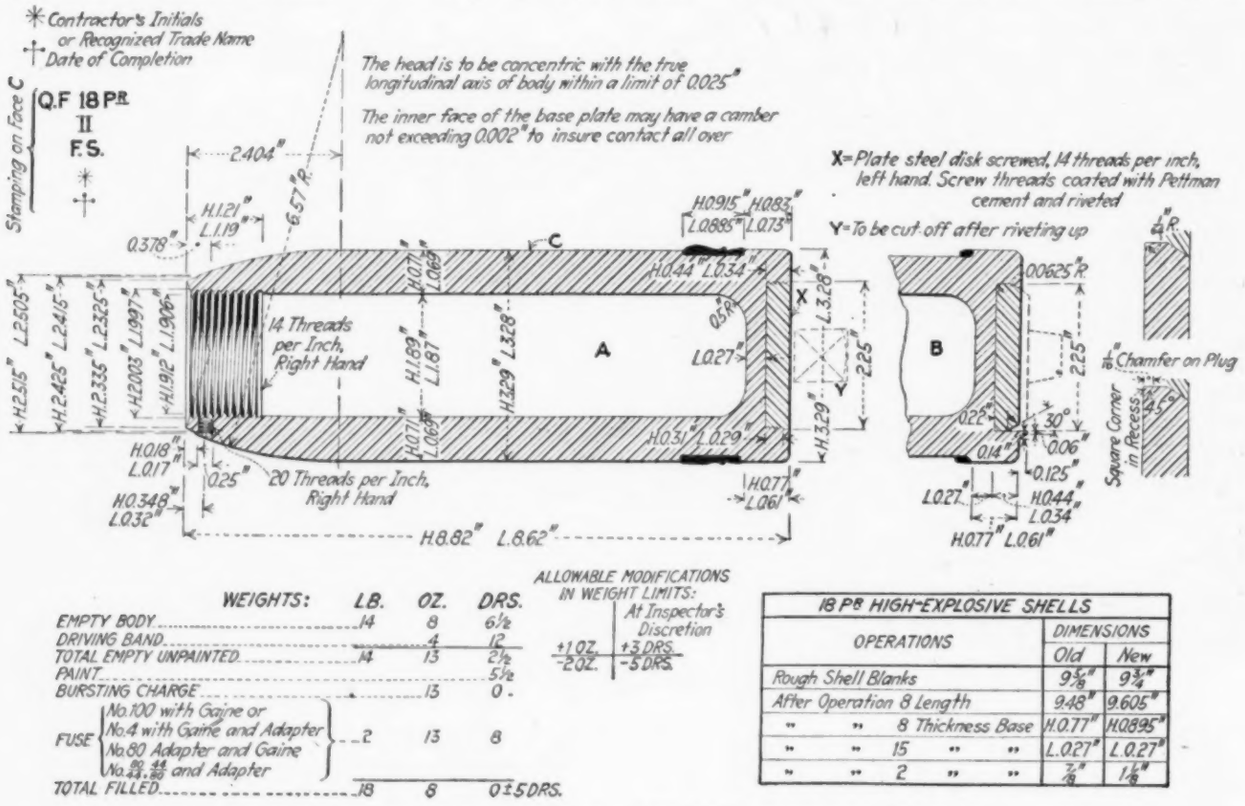

* Contractor's Initials or Recognized Trade Name
† Date of Completion
Stamping on face C
Q.F 18 PR
II
F.S.
The head is to be concentric with the true longitudinal axis of body within a limit of 0.025"
The inner face of the base plate may have a camber not exceeding 0.002" to insure contact all over
X=Plate steel disk screwed, 14 threads per inch, left hand. Screw threads coated with Pettman cement and riveted
Y=To be cut off after riveting up
2.404"
6.57" R.
0.378"
14 Threads per Inch, Right Hand
20 Threads per Inch, Right Hand
0.25"
A
B
C
0.0625" R.
1/16" Chamfer on Plug
Square Corner in Recess
H.8.82" L.8.62"

FIG. 3. THE 18-LB. SHELL WITH OLD AND NEW TYPES OF BASE PLATES

WEIGHTS:	LB.	OZ.	DRS.
EMPTY BODY	14	8	6½
DRIVING BAND		4	12
TOTAL EMPTY UNPAINTED	14	13	2½
PAINT			5½
BURSTING CHARGE		13	0
FUSE (No.100 with Gaine or No.4 with Gaine and Adapter or No.80 Adapter and Gaine or No. 80, 44, 66 and Adapter)	2	13	8
TOTAL FILLED	18	8	0±5 DRS.

ALLOWABLE MODIFICATIONS IN WEIGHT LIMITS: At Inspector's Discretion

+1 OZ. +3 DRS.
-2 OZ. -5 DRS.

18 PR HIGH-EXPLOSIVE SHELLS					DIMENSIONS	
OPERATIONS					Old	New
Rough Shell Blanks					9 5/8"	9 3/4"
After Operation 8 Length					9.48"	9.605"
"	"	8	Thickness	Base	H.0.77"	H.0.895"
"	"	15	"	"	L.0.27"	L.0.27"
"	"	2	"	"	7/8"	1 1/8"

fulfilled these requirements a heat number is marked on each lot in the steel mill.

In the Dominion Bridge Co.'s plant, but not in the No. 2 shop, there are three heavy cold-sawing machines used for sawing blanks from bar stock. However, as these are unable to keep up with the demand, blanks already cut to length are bought from other shops.

The various ways of cutting blanks have already been shown in the *American Machinist*, but a short résumé may be of value here, especially as the files of the paper may not be at hand for ready reference.

The methods include cold-sawing singly or in multiple in cold-sawing machines; cold-sawing by a quasi-continuous method in a heavy wide-slab miller equipped with a jig for holding a number of bars at a time and having a gang of cold-saws mounted on the arbor; multiple parting on a heavy wide planer equipped with a jig for

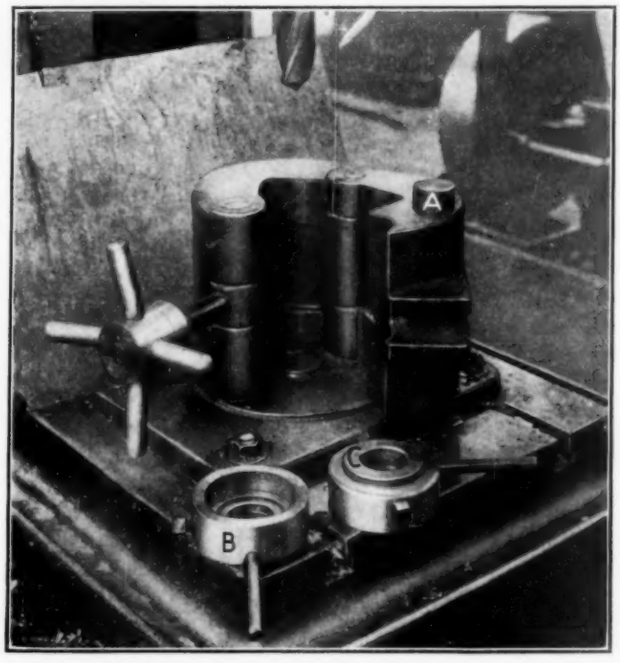


FIG. 4. HINGED DRILL CHUCK

holding a number of bars and with two or four tools in the heads; single cutting in a turret lathe and single cutting in a cutting-off machine.

The output by the various methods varies considerably. A standard Gorton hollow cold-saw working on a single bar 3½ in. in diameter can cut about 19 blanks per hour. A heavy cold-sawing machine with four bars in the vise at a time can cut about 25 blanks per hour. A turret lathe or cutting-off machine in which the work is rotated can cut off about 25 blanks per hour. A heavy slab miller wide enough to pass between its housings bars four blanks in length and having on its table a jig about 12 ft. long can, with four saws on the arbor, by the quasi-continuous method, cut about 38 blanks per hour. It must, however, be remembered that when this method is used, the commercial bars must first be cut to length to pass between the housings of the machine. After cutting, the heat number is stamped on the base of each blank.

The cut blanks for the 18-pounder high-explosive shell are brought to the No. 2 shop on cars either from their own saws or from the outside source of supply. The cars are unloaded and the blanks, piled on shop trucks, are run to the first operation, which consists of grinding off the burr left by the cold-saw. This is removed, as it might prevent the blank from centering properly in the chucks in the first machining operation. For this work an ordinary dry-grinder is used with a wide rest for the work, as shown in operation sheet 1. A man can remove the burrs from about 300 blanks per hour.

To digress for a moment: In Canada, and I suppose elsewhere, more shells have been scrapped because they were under weight than for any other single reason. Knowing this the executives decided to obviate it by the very simple expedient of working to the high limits from the start. It would then be an easy matter to bring the shell to weight by turning off or boring out the excess of

TABLE 1. LAYOUT OF WORK; MAKE AND CAPACITY OF MACHINES

Operation	Number of Machines in Operation	Size and Name of Machine	Capacity per Machine Per Hr.	Per 22-Hr. Day	Total Capacity in Shells
Drill	9*	24-in. Foote-Burt	5	110	990
	11*	25-in. Foote-Burt	5	110	1,210
	3	2-Spindle Bertram	12	264	792
	10	Dom. bridge drills	15	345	3,450
Center	3	Herbert drills	65	1,430	4,290
Rough turn	10	24x10 C.M.C. lathes	20	440	4,400
Rough nose	2	18x8 Mueller	23	506	4,554
	6	24x10 C.M.C.	23	506	
	1	18x8 McDougall	23	506	
Face base	4	20x6 Gardner	48	1,056	4,224
Face to length	3	20x6 Gardner	30	660	1,980
Bore and ream	12	3x36 J. & L.			
	4	3x36 Acme			
	6	2x24 J. & L.	9	198	4,752
	2	2x26 P. & W.			
Thread nose	8	Thread millers	25	550	4,400
Finish turn	4	18x8 C.M.C.			
	1	18x8 Walcott			
	1	16x6 American	20	440	4,400
	1	16x6 Champion			
	3	18x8 Mueller			
Face to weight	6	20x6 Gardner	35	770	4,620
Round corner, groove	6	20x6 Gardner	35	770	4,670
Wave and undercut	9	20x8 Gardner	21	462	4,150
Recess base	2	2x24 J. & L.			
	2	18x8 Mueller	25	550	4,400
	4	20x10 C.M.C.			
	2	16x6 Gardner			
File base to gage	2	16x6 Prentiss	35	770	4,620
	1	16x6 Flather			
	1	16x8 Twink			
Mill base thread	6	Thread millers	36	790	4,740
Drill ¼ hole in Nose	1	4-spindle drill	200	4,400	4,400
Tap ¼ hole	3	Herbert drills	80	1,760	5,280
Marking	2	London air markers	125	2,750	5,500
Saw-off square on base plate	6	Racine hacksaws	25	550	3,300
Rough face base plate	6	20x6 Gardner	35	770	4,620
Rivet base plate	2	High speed hammers	100	2,200	4,400
Finish face base plate	7	20x6 Gardner	30	660	4,620
Band press	1	6-cylinder Lymburner	120	2,640	5,280
	1	West Tyre Co.			
	2	20x8 C.M.C.			
Band turn	1	18x12 L. & S.	50	1,100	4,400
	1	Jeneckes			
Threading base plates	8	Automatic (Bridgeport)	10	220	1,760
Turn base plates	4	16x6 S. Bend	75	1,720	4,300

In addition to the lathes listed there are on shell work, exclusive of the toolroom 1 London 18x12; 1 C.M.C. 20x8; 1 C.M.C. 18x8; 1 J. & L. 2x24; 1 C. M. C. 20x8; 1 Gardner 20x6.

* These machines will be dispensed with.

metal. Figured from the drawing of the shell shown in Fig. 3 the sum of the allowances amounts to nearly a pound, and the tolerances of weight on the finished empty body allow a total variation of 3½ oz. At *A* in Fig. 3 is shown the 18-pounder as originally made. It will be noted that it has a threaded base plate similar to that in the 4.5-in. shell recently described in the *American Machinist*. The manufacture of a shell with this type of base plate if all the Government requirements are adhered to is not nearly as easy a job as it may seem. The thread is of the Whitworth standard and is very difficult to make and keep correct. The thread alone is not depended on to seal the base, Pettman cement being smeared on the threads before screwing it in and a final riveting operation being performed on the plate to close the base recess hermetically. Everyone knows that hammering on male and female threaded members loosens rather than tightens them. For this reason it is probable that many base

plates which were a fairly close fit when screwed into the base recess were so slackened after riveting that they would not pass inspection. To obviate these difficulties, the base plate shown at *B*, Fig. 3, was devised. With it threading of the base recess and base plate are eliminated. The recess is a plain cylindrical blind hole with a fillet in the corner. Nothing could be easier to make right and keep so. The only extra work with this type of base plate is the turning of the base for the riveting flange *C*, or "angle," as it is termed in the shop operation. This also makes necessary an additional 1/8 in. of length on the blank to provide for the riveting angle. The amount of riveting necessary with this type of base plate is a little greater than that necessary with the threaded type, but riveting is a simple operation and does not require either a great amount of time or a high degree of skill.

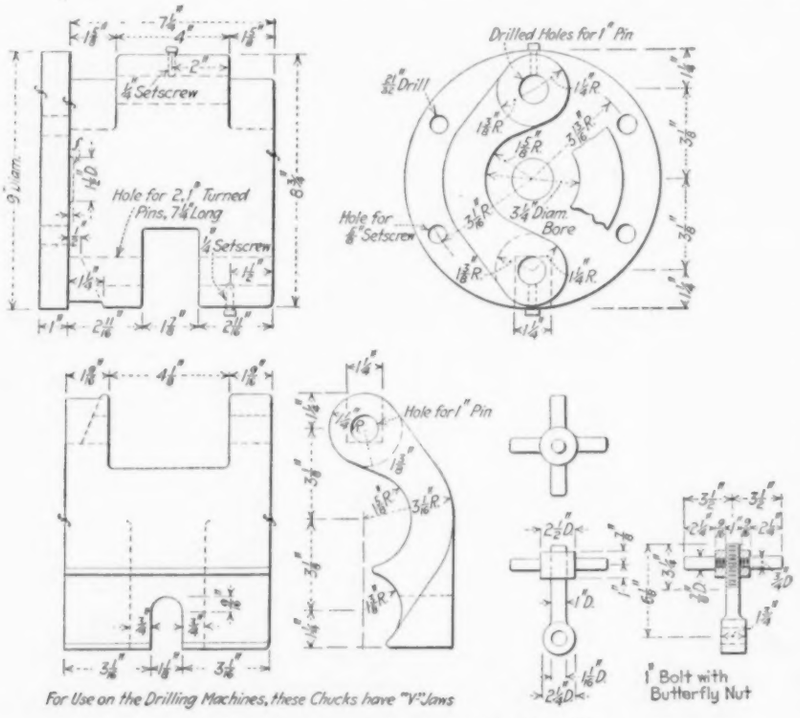

Drilled Holes for 1" Pin
Hole for 2.1" Turned Pins, 7¼" Long
¼ Setscrew
Hole for ⅜" Setscrew
3¼ Diam. Bore
Hole for 1" Pin
For Use on the Drilling Machines, these Chucks have "V" Jaws
1" Bolt with Butterfly Nut

FIG. 5. DETAILS OF HINGED CHUCK

The base plate is a plain cylinder with a rounded edge and a conical portion at the back, over which the riveting angle is turned in the riveting operation. It is a simple piece to make accurately and is turned out on plain engine lathes.

The use of this type of base plate, besides calling for a shell blank 1/8 in. longer than with the original base plate, requires slight changes in four of the operations, as shown in the table attached to Fig. 3. In this table the threaded type of base plate is referred to as the "old" and the unthreaded as the "new" type of base plate. Having had the burrs ground off, the blanks are taken by the truck gang to the drilling machines.

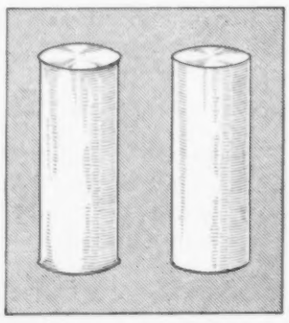
The drilling operation is, from the viewpoint of time consumed, the most important of the machining operations. Three different makes of machines are used for this operation. There are nine 24-in. and eleven 25-in. Foote-Burt heavy-duty drilling machines, three 2-spindle Bertram horizontal drilling machines and sixteen Dominion Bridge Co.'s air-feed horizontal drilling machines.

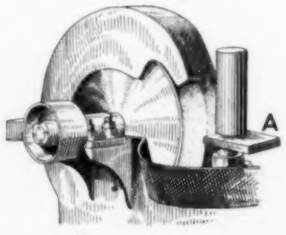
The hole to be drilled in the blank is $1\frac{13}{16}$ in. in diameter, $8\frac{3}{4}$ in. deep. In drilling deep holes the problem is not so much the cutting of the metal as the removal of the metal after it has been cut; that is to say, the removal of the chips from the hole to prevent them from choking the drill. The difficulty of chip removal is much greater with vertical machines than with horizontal ones. In vertical machines a drill must be used that will clear itself, as it is very difficult to install oil or water-tube drills in such a manner that they will not sling the lubricant. For that reason twist drills have been and always will be popular for use with vertical machines. They keep the chips moving upward, and a small amount of the flood of coolant no doubt gets down the hole to within a few inches of the cutting edges.

The great objection to twist drills at this time is their cost. At the time of writing, a $1\frac{13}{16}$-in. twist drill made of high-speed steel, of the length required for drilling 18-pounder blanks, costs from $55 to $60, depending on the make. In normal times the same drill can be bought for from $10 to $12. The average life of such a drill is about 450 holes; thus the drill cost alone is about 13c. per hole apart from the labor and other charges.

With horizontal machines the conditions are entirely different. There is no great difficulty in installing oil- or water-tube drills. With these installed it is only a question of pressure on the lubricant to determine how fast the chips shall come out of the hole. With these drills the lubricating of the cutting edge is also settled, for the lubricant must go to the end of the hole before it can return, bringing the chips with it.

A further advantage with this type of drill is its low cost. The body of the drill can be made of any good bar stock. Steel about 60 to 70 points carbon, well hammered, makes a good stiff shank for such a drill, and two high-speed bits costing at the present time 50c. each will do as much work as a $60 twist drill. Further, if the drill be properly made it will drill a hole that no twist drill can approach as regards accuracy.





OPERATION 1: REMOVE BURRS FROM BLANKS

Machine Used—Dry grinder.
Special Tools and Fixtures—Wide rest A set in line with the wheel center.
Gages—None.
Production—One man and one machine, 300 per hr.
References—None.

On the Foote-Burt drilling machines two types of chucks are used to grip the work. The one shown in Figs. 4 and 5 was the first one designed for use on the drilling machines and was not very satisfactory, but is all right for use on the benches, where it is now used. Rapid manipulation was not possible, and the chips gave more or less trouble as there was no way for them to fall clear through. The little block shown at *A* is for setting the drill to depth when a newly ground drill is inserted in the spindle and the feed stop is to be set. The bushing *B* is for centering the drill at the start of a hole. The large part of the bore of *B* is a somewhat slack fit on the rough shell blank. This cannot be otherwise, as the hot-rolled stock from which the blanks are cut varies somewhat in diameter. The operator on starting a new hole places the bushing *B* over the end of the blank with the drill guiding bushing up, as shown at *C*. He then runs the drill in till the lips are below the surface. The drill is then elevated, the bushing removed, the drill lowered to cutting position and the automatic feed thrown in.

The holding jig in Fig. 6 is much better and quicker. The two jaws are operated by a right- and left-hand screw controlled by the handwheel *A*. There is plenty of space between the jaws so that the chips can be swept out when chucking a new blank. Centering at present is accomplished in the same way as with the old chuck, but a centering device is now being made for these drilling machines to center the drills positively, irrespective of the diameter of the blank. This drill guide is shown in Fig. 7. The bracket *A* is made of steel plate 1⅛ in. thick, forged to shape. It is gibbed and doweled to the ways that carry the table of the machine. The two arms *B* are pivoted at *C* to the bracket *A*. The swing bolt *D* clamps them securely together at the forward end, and the stop *E* assures that they always register properly. At *G* is the guide for the drill. The hole *G* is bored after the device is set up in place. The knurled nut on the bolt *D* is easily operated without a wrench; the arms can

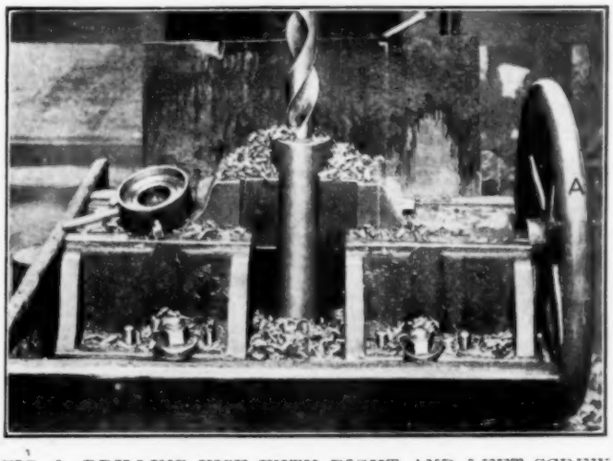
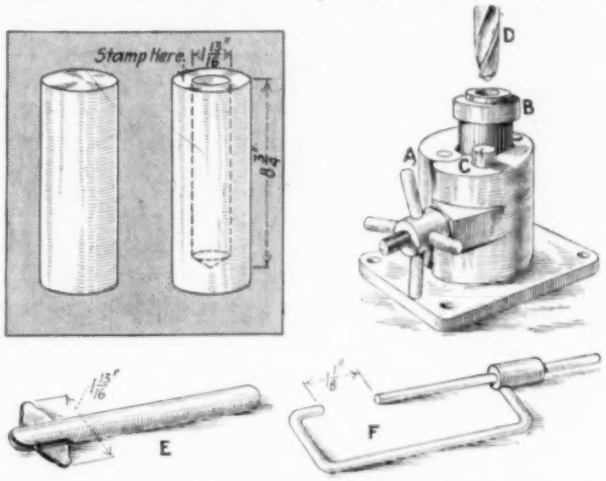


FIG. 6. DRILLING VISE WITH RIGHT AND LEFT SCREW

then be swung out of the way and the work placed or removed.

Two Foote-Burt drilling machines are attended by one operator. Their nominal output is 5 pieces per machine per hour. A man can, however, do a little better than this, but in many of the shops where these machines have been forced there has been more or less trouble with breakage, so it has been found more economical to run slower.

The Dominion Bridge Co.'s air-feed drill is a recent development. Mr. MacDonald, manager of the ordnance department, is responsible for it, and in it he has nothing of which to be ashamed. It is simple and rugged in construction, drills a more accurate hole than the vertical machine in about a third of the time and costs very much less. The machine is shown in Figs. 8 and 9, together with the drill used. The air cylinder *A* is 7 in. in diameter and is supplied with air at 90 lb. per sq.in., giving a total pressure of about 3,500 lb. on the piston and drill. The piston rod *B* is 4 in. in diameter and at its forward end is secured to the sliding saddle *C*. A taper reamed socket in the extreme end accommodates the drill shank. The drill is hollow, and lubricant under pressure is admitted to it through the connection at *D*. The belt-driven pump *E* supplies the lubricant at present. The main spindle of the machine is 6 in. in diameter. At the forward end is a heavy combination chuck for holding the work. The rim of the faceplate that carries the chuck is used as a brake drum, the band of the brake being controlled by the lever *F*. In front of the rear spindle bearing is a ball thrust bearing *G* to take the drilling pressure. With one of these machines a man can drill 15 blanks per hour.



OPERATION 2: ROUGH DRILL

Machines Used—Foote-Burt vertical drilling machines. Dominion Bridge Co.'s air-feed horizontal drilling machines. Bertram two-spindle horizontal drilling machines.
Special Tools and Fixtures—Chuck like A or vise with R- and L-screw operated jaws for the vertical machines. Centering jig B. Drill setting block C. 1¹³⁄₁₆ in. twist drill D. For horizontal machines 1¹³⁄₁₆ in. hogging drill is used.
Gages—Diameter gage E. Base thickness gage F.
Production—One man and 2 vertical machines, 10 per hr. One man and one horizontal machine, 15 per hr.
Note—Drilling compound used as lubricant.
References—See Figs. 4, 5, 6, 7, 8, 9 and 10.

After the blanks are drilled the work is inspected for diameter of hole and thickness of base by one of the four inspectors assigned to the drilling department, who uses the gages shown in the second operation sheet. Work that passes inspection is stamped by the inspector as indicated in the operation sheet. The checker now credits the driller with the number of pieces drilled, the truck gang is notified and the work loaded on trucks and transferred to the next operation.

Before passing to the next operation it may be well to call the reader's attention to the fact that even the location of the inspection marks has been standardized. While this may seem a small matter it is in reality the means of saving a great amount of time, for there is little expense of effort in looking for a thing when one knows just where to find it. The location of the various marks

is shown in their entirety in Fig. 10. Besides these marks the steelmakers' heat or melt number must always be kept on the work. Before those operations which remove it from the work, it must be stamped on the side or end of the piece, whichever will leave the mark uneffaced after the operation is completed. The next operation is centering. The center must conform as nearly as possible with the axis of the hole, not the outside of the piece. The work in place in the jig is shown in Fig. 11 and the details of the jig in Fig. 12. The work *A* is slipped over the vertical post, the leaf *B* swung on the pivot *C* to the position shown in Fig. 11 and the pin *D* entered in the hole in the top of the side post *E*. By referring to Fig. 12 it will be seen that the weight of the piece and the drill pressure throw three radial locking pieces which prevent the piece from turning. At the top of the center post is the wedge-like plunger *A*. A helical spring normally keeps it up in the position shown. Three radial jaws *B* are disposed 120 deg. from each other around the conical part of the plunger *A*. When the drilled blank is placed over the post it forces the plunger downward, and it in turn forces the three radial jaws outward. These simultaneously center the work with relation to the hole, grip it and prevent it from turning during the centering operation. The scheduled time on this operation for a boy is 65 blanks centered per hour, but this operation has been done at the rate of over 81 blanks per hour for a period of 10.5 hr.

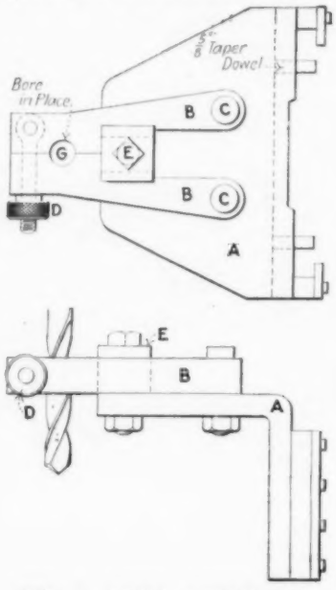
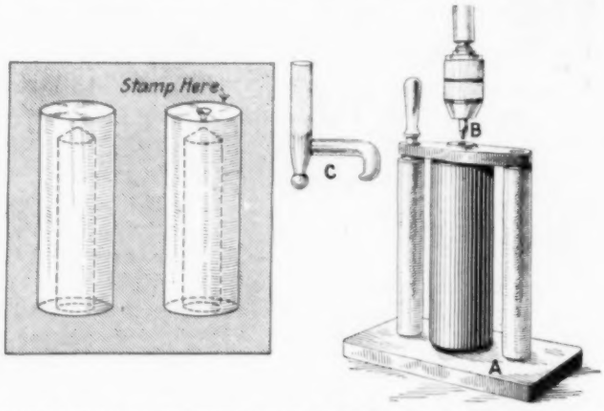


FIG. 7. DRILL GUIDE FOR FOOTE-BURT DRILLING MACHINES

After centering, the work is again inspected to see that there is enough metal all around for the shell to clean up properly in the subsequent operations. The inspection gage is a set wing gage with a ball point, and the work is marked, all as shown in the third operation sheet and Fig. 10. The checker tallies the work, after which the truck gang collects and distributes it to the machines on the next operation.



OPERATION 3: CENTER THE BASE END OF THE BLANK
Machines Used—Herbert sensitive drilling machines.
Special Tools and Fixtures—Centering jig A. Combination center drill B.
Gages—Wing caliper gage to test if stock will clean up.
Production—One machine and one boy, 65 per hr.
References—See Figs. 10, 11 and 12.

The next operation is done on 24-in. by 10-ft. engine lathes. In the spindle nose there is a plug center to fit the hole in the shell blank, and on the nose a driver plate. An ordinary lathe dog is tightened on the open end of the shell blank, the hole in the blank entered on the plug center and the center in the base entered on the tail center, all as shown in Fig. 13 and the fourth operation sheet. The tool is an ordinary roughing tool; the cut is run toward the headstock as far as the dog will permit. The operator has two snap gages for this operation. They are

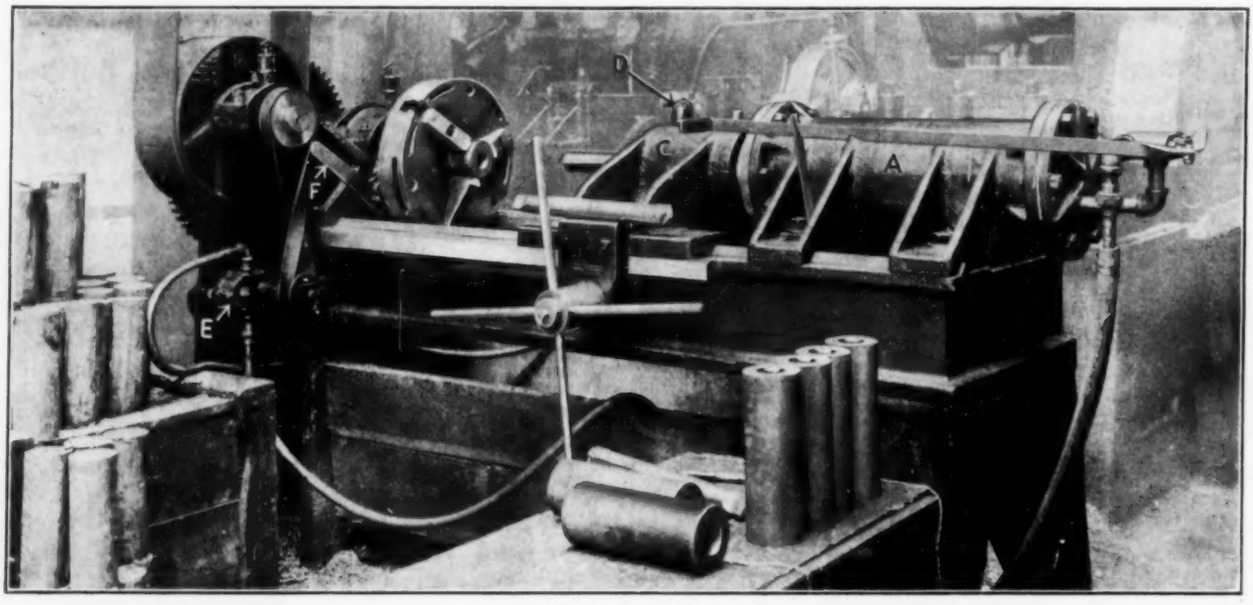


FIG. 8. DOMINION BRIDGE AIR-FEED DRILLING MACHINE

3.330 for the high and 3.320 for the low, a fairly large allowance for a piece of this diameter even on a rough-turning operation. The scheduled output for this operation is 20 pieces per hour. However, if the steel in the blanks is not too hard and the tools are of good steel and well-tempered, a man can average 28 pieces per hour.

The inspection for this operation requires the same gages as those used by the operator. After the blanks are passed and marked by the inspector, a boy assigned to the rough-turning operation makes the first transfer of the heat number from the base of the blank, where it was put by the steelmaker, to the side of the shell.

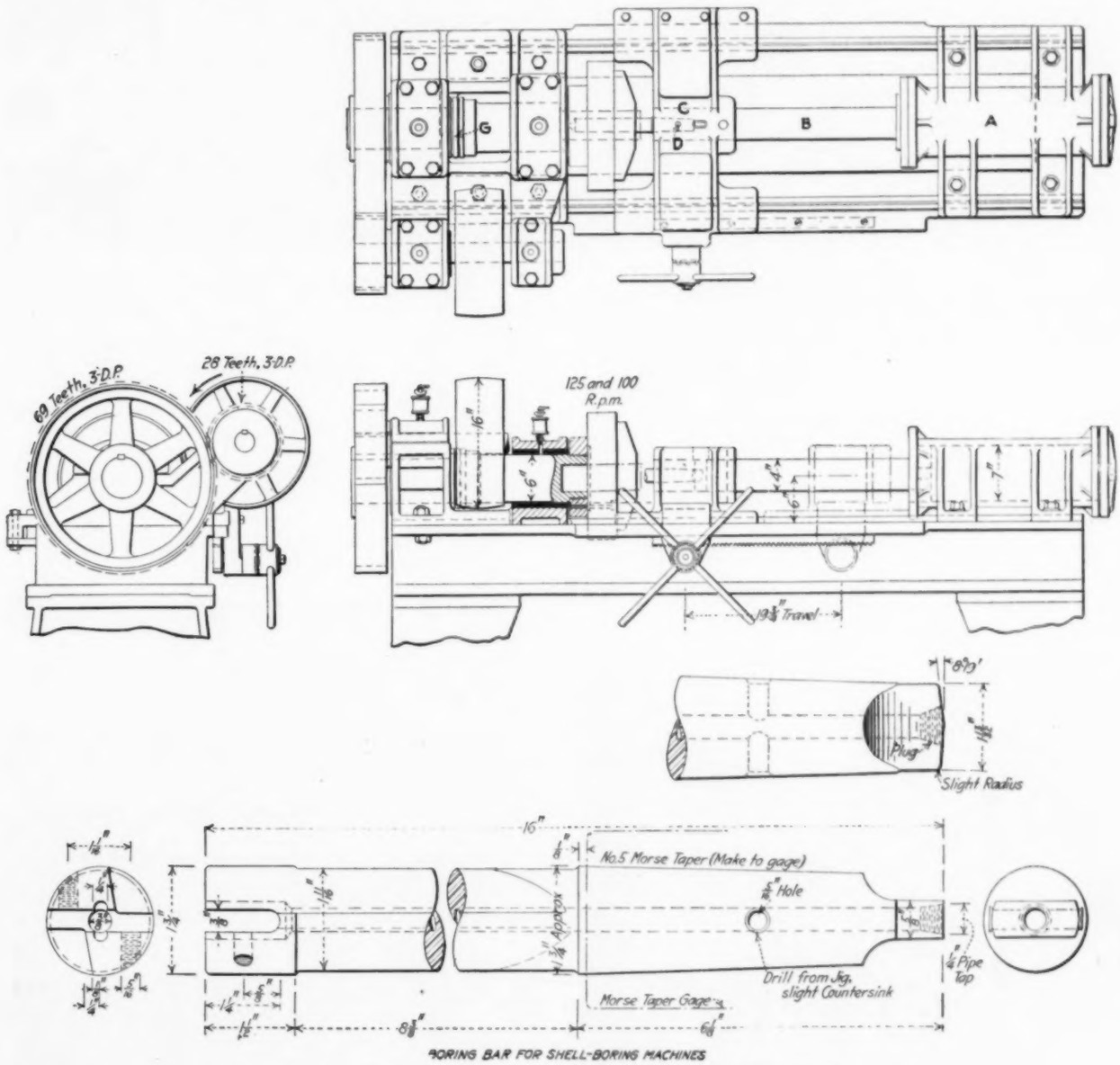
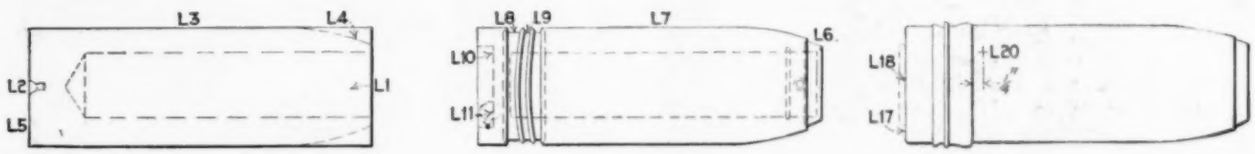


FIG. 9. THE HIGH-EXPLOSIVE SHELL-BORING MACHINE



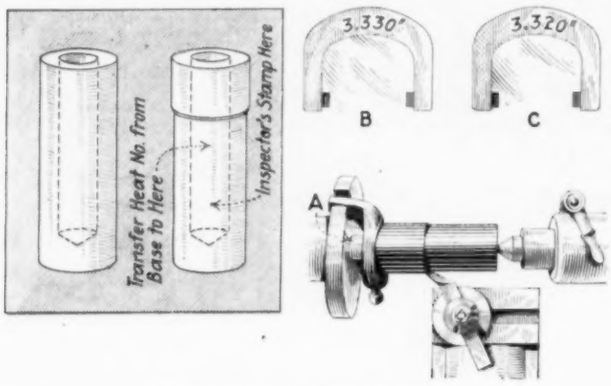
Operation	Description	Stamp, In.	Operation	Description	Stamp, In
L1	Drill 1⅛ in. ϕ hole	¼	L11	Mill base thread	⅛
L2	Center	¼	L12	Drill ¼ in. ϕ hole	none
L3	Rough turn body	¼	L13	Tap ¼ in. ϕ hole	none
L4	Rough turn nose	¼	L14	Screw in base plugs	none
L5	Face base	¼	L15	Saw off square end	none
L6	Bore, ream and tap inside	⅛	L16	Rough face plug	none
L7	Finish turn	¼	L17	Rivett or roll plug	¼
L8	Face base round corners and rough groove	¼	L18	Finish face plug	¼
L9	Wave and undercut	¼	L19	Band press	none
L10	Recess base	¼	L20	Band turn	⅛

All men, whether on piece work or daywork, must stamp all shells as shown above.

FIG. 10. STANDARD STAMPS FOR OPERATIONS ON THE 18-POUNDER HIGH-EXPLOSIVE SHELL

The checker then credits the operator with the work, and the truck gang transfers the shell blanks to the next operation.

The next operation is roughing the nose. This work is done on 18- and 20-in. engine lathes. An ordinary lathe dog is tightened on the base end of the blank. The live spindle carries a 60-deg. center and driver plate. The tail spindle carries a plug center with a thrust collar so that it will turn easily. In the tool post there is an ordinary roughing tool. The crossfeed of the tool is made with the compound slide. The lengthwise feed is under the control of a former at the back of the lathe. A roller bears on the former and is kept in contact with it by a fairly stiff spring. The first of these forming attachments in use at this shop had a plain former with a follower of the "knife-edge" type. This was not satisfactory. The next one tried was equipped with a cam groove and roller fitting it. This also proved unsatisfactory, so the present type shown in operation sheet five was installed and has given no trouble. It is well to remember that devices like this should be kept well lubricated and should be well protected from dirt and possible damage. The attachments in use here have a fairly heavy sheet-iron cover, so made that it can be readily removed.



OPERATION 4: ROUGH TURN

Machines Used—18- and 24-in. engine lathes.
Special Tools and Fixtures—Plug center A.
Gages—High and low limit snap gages B and C.
Production—One man and one machine, 20 per hr.
Note—Cutting compound used.
References—See Fig. 13 and Fig. 10 for position of inspector's mark.

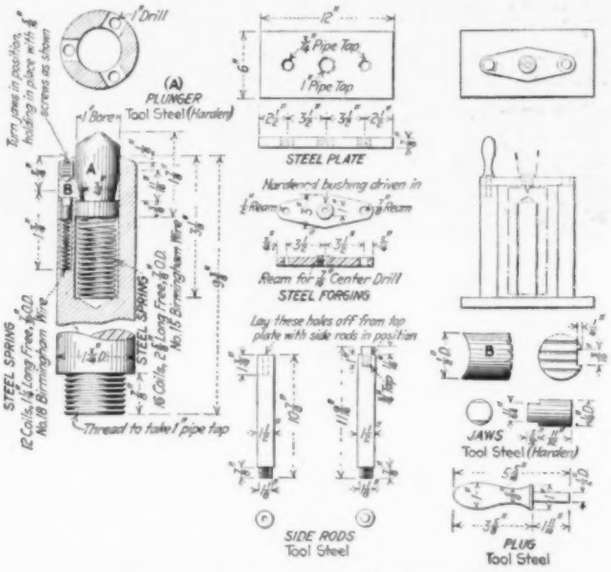


FIG. 12. DETAILS OF CENTERING

The feed of the lathe for this operation is away from the headstock. Two cuts are taken with an ordinary roughing tool. The first one starts at the point where the roughing cut in the former operation left off, but not quite to the same depth. The second cut is started a little way back on the parallel part of the body and to the same diameter as the rough body size. The scheduled out-

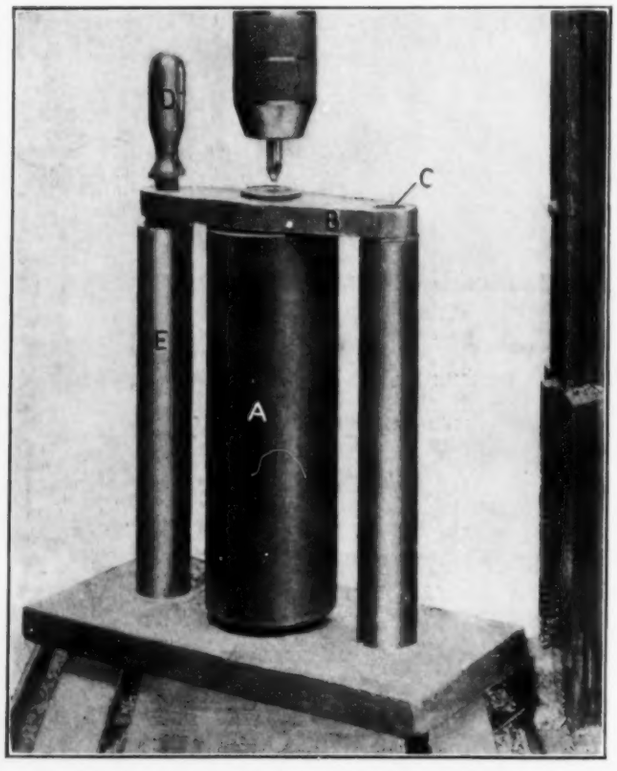
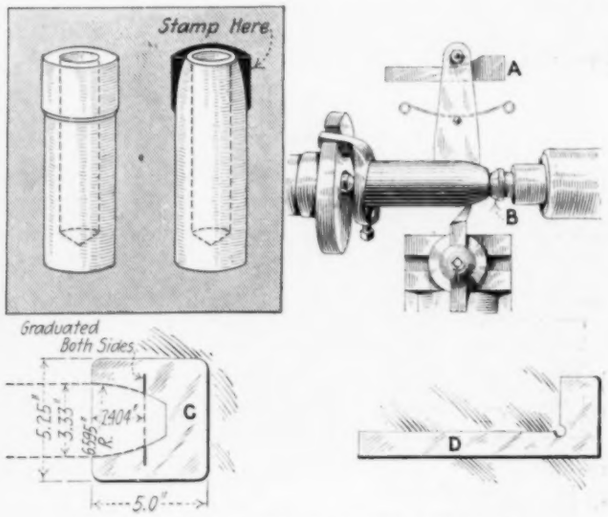


FIG. 11. CENTERING THE BLANKS



OPERATION 5: ROUGH TURN THE NOSE

Machines Used—18- and 24-in. engine lathes.
Special Tools and Fixtures—Former and roller A. Plug center B.
Gages—Profile gage C. Over-all length gage D.
Production—One machine and one man, 23 per hr.
Note—Cutting compound used.
Reference—See Fig. 14 and Fig. 10 for position of inspector's mark.

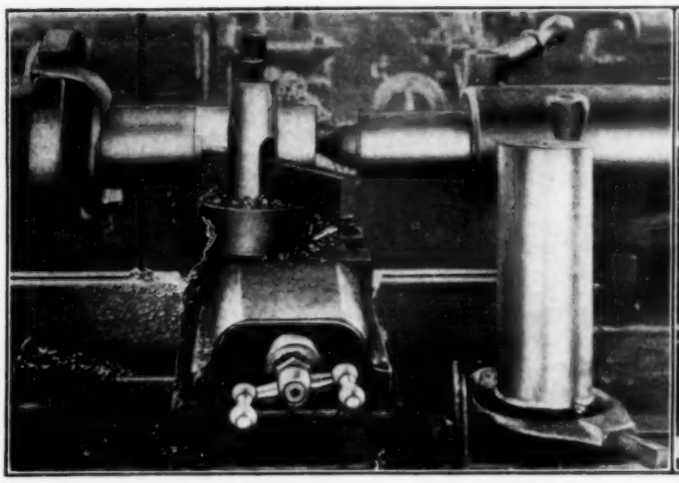


FIG. 13. ROUGH TURNING THE BODY

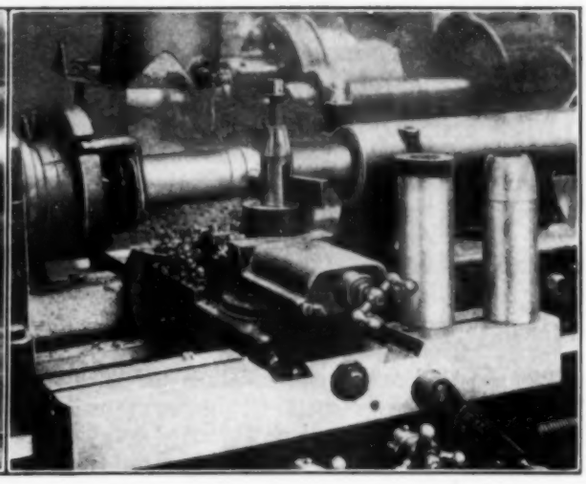


FIG. 14. ROUGH TURNING THE NOSE

put on this operation is 23 per hour, but with everything going right a man can get out 28 pieces per hour.

The work is now inspected to see if the contour of the nose is correct and if the length overall is right, and the inspector's stamp is affixed to the work, all as shown in the fifth operation sheet. The checker now credits the workman with the number of pieces passed and the truck gang transfers the shells to the next operation.

A Shell Shop Built in 17 Days

FIG. 1. JUNE 14, 1915. 9:45 A.M.

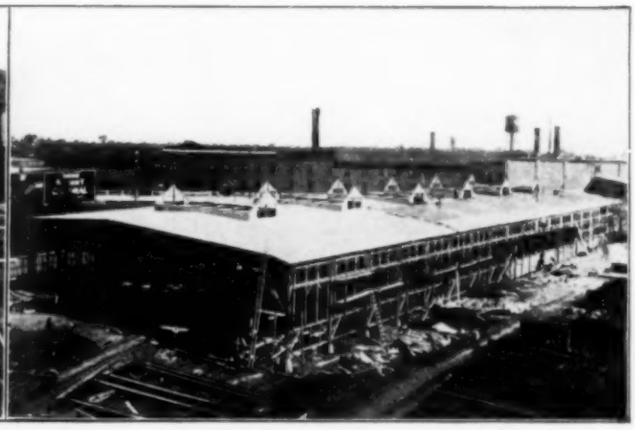


FIG. 2. JUNE 21, 1915. 3:15 P.M.

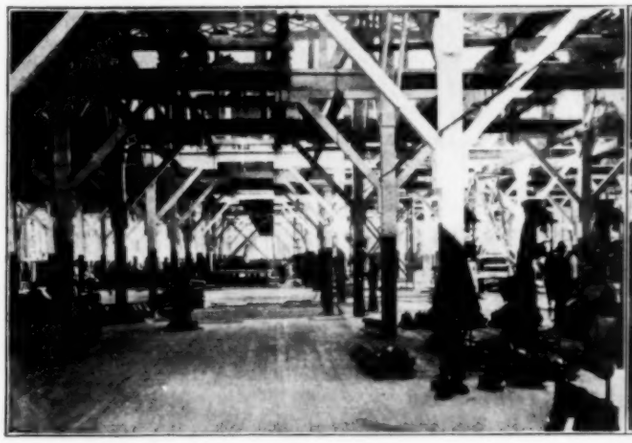


FIG. 3. JUNE 28, 1915. 3:30 P.M.

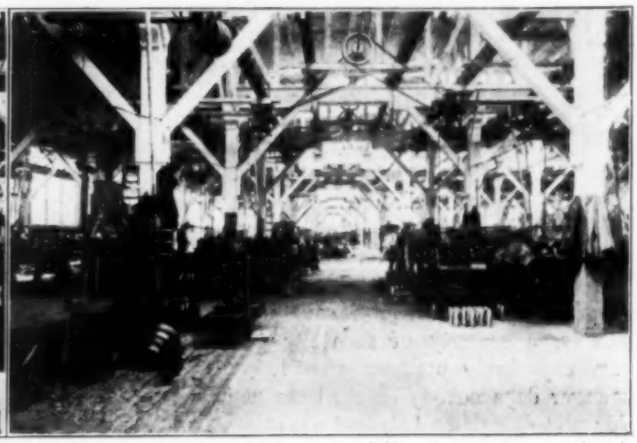


FIG. 4. JULY 5, 1915. 3 P.M.

This is a little story, practically without words, of how the Dominion Bridge Co., Montreal, Canada, built the No. 2 Shell Shop for the manufacture of the 18-pounder high-explosive shell. The shells at the right on the floor in Fig. 4 were made in this shop. It will be noted that the date on this photograph is July 5 and on Fig. 1 it is June 14

Miller Designer and Shop Superintendents

By E. P. Armstrong

I have never seen a miller either in stock or in print that struck me as having a long enough saddle for the traveling table to work on. In the construction of planers the bed, or in other words the ways that the table slide on, are always of sufficient length so that when the table is at its extreme of travel at either end it will lie down in the ways naturally; that is, the center of gravity of the table or bed is always within the scope of the slides that support the movable table.

In almost all millers the saddle is too short for this. When the table travels toward either end a little way beyond the center, the center of gravity gets beyond the end of the support; it is useless to say that the slides should fit close enough to cause the table to travel in a straight line from end to end, because it will not do it, especially when mounted with heavy index centers and the work, or with other heavy fixtures for manufacturing. I realize that in the case of universal millers a long slide might interfere when the table is set at an abrupt angle. However, the miller could be designed so that the long slide would not interfere. It would not need to be wider than the oil catcher on the table so that if the table were clear, the headstock when swung around at an angle, the slide would also clear it. The slide should always be long enough so that the center of gravity of the table would always be within the slide.

There have been such rapid advancement and such radical changes in millers within the last few years, I have been hoping to see somebody heed this plain requirement. As I expect to be in the market for one or more milling machines in the near future, I am much interested.

Another question I should like to see discussed more forcibly in the near future in your paper is on the requirements of a shop superintendent. The scarcest men in the country today are men who are capable of satisfactorily filling the superintendent's position not only in machine shops, but in various other institutions. There is a reasonable supply of skilled workmen, but they lack training for superintendents. There seems to be in papers like yours a lack of the use of printers' ink bearing on the needs in this line. Young men and machinists who are ambitious and wish to become superintendents should have constantly available pointers and information showing them the things they need to learn to fill this important position, because it is not altogether a question of skill in cutting iron and machinery, but of broad-sightedness, diplomacy and tact coupled with well-developed executive ability.

Men need ability not only to carry out an established system themselves in every detail, but to see that those under them do it. A perusal of the want ads in your paper every week shows conclusively my contention, namely, a scarcity of men for responsible jobs. My own experience prompts this letter to you. In my younger days nobody coached me or called to my attention the difference between a workman, no matter how skillful, and a man filling a position of responsibility. And it took me many years to get on the right track. A little plain, straight-forward, consistent, wholesome exposition of this subject would be of great value to the machine-shop and other industries in this country. And do not print it one week and then drop it; but select a suitable place in your paper and print a short piece in condensed form, yet comprehensive, and leave it there constantly.

I hope these suggestions may help along the principles that your valuable paper stands for.

Ornamental Foundry in Brazil

The highly utilitarian American usually discards all ornament when building his shop and would consider unnecessarily ornamental such a foundry front as shown herewith. There is, however, another side to the story, and it is an open question whether a little more attention to ornamentation might not pay in its effect on a city and its people. The group of manufacturers who have built on University Ave., Rochester, N. Y., seem to feel that this is the case.

AN IRON FOUNDRY IN BRAZIL

The illustration shown is the front of the foundry of Carvalho Paes & Co., in Rio de Janeiro, Brazil, which is certainly more of an ornament to a city than many to be found in this country.

Important Constituents of Steel—The most important constituent of steel, upon which the nature of the metal largely depends, is carbon. Depending upon the carbon content, ordinary steel castings vary from very soft to dead-hard steel. The carbon content in each class of steel castings is approximately as follows:

Class	C., per Cent.	Special Trade Names
Very soft	Up to 0.15	"Malleable-Iron Castings"
Soft	0.15 to 0.30	.....
Medium	0.30 to 0.40	.....
Hard	0.40 up	"40-Point Steel"

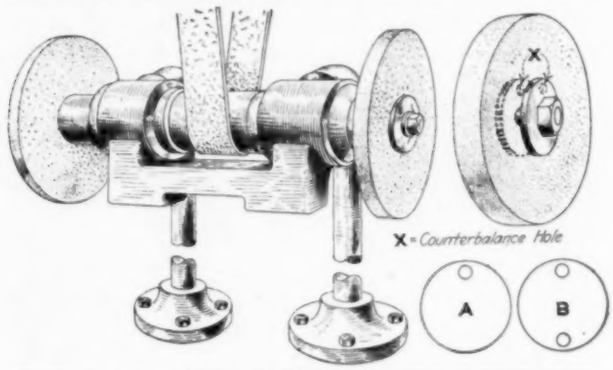
The effect of silicon in steel castings is chiefly to promote soundness and to discourage the formation of blow-holes. The average silicon content of steel castings is from 0.25 to 0.40 per cent., though in "very soft" steel it is sometimes as low as 0.15 or even 0.10 per cent. The silicon content should not be specified by the purchaser but left to the judgment of the maker. Manganese in "very soft" steel castings is sometimes as low as 0.20 per cent., but in the average casting it runs from about 0.40 to 0.80 per cent., or even higher. As manganese additions are absolutely essential in the manufacture of steel, and in most cases the steel could not be made sound at all without it, the manufacturer is in a position to know how much he should use and should not be hampered by limits imposed in specifications. The effect of phosphorus in steel is to produce brittleness in the metal when cold. Hence the limits are sharply specified. No steel casting should contain over 0.10 per cent. of phosphorus, and 0.08 per cent. is better.

The Small-Shop Grinding Wheel

By John H. Van Deventer

SYNOPSIS—Although often wrongly selected, incorrectly mounted, improperly speeded and unfavorably used, the small-shop grinding wheel plays no inconsiderable part in getting out the work. This article is intended as a help to the better understanding and use of this crude but effective shop appliance.

Some day perhaps the creator of "Happy Hooligan" will lead him into a small machine shop and then show us in pictures what happens to him. The old fellow must be getting tired of the regular routine of mishaps and would appreciate something different, such as getting bumped with a planer table or being scalped by a driving belt. But for all-around entertainment let him be introduced to a grinding wheel. Picture to yourself the expression of his face after feeling of the wheel with his fingers or upon taking hold of the "heavy" end of the piece of work! Imagine him trying to light his "snipe" at a stream of sparks. Picture him reclining gracefully against a swiftly moving snagging wheel and then making a hasty exit with a newspaper held to conceal the damages!



FIGS. 1 AND 2. TWO WAYS OF SIDETRACKING THE VIBRATION QUESTION

The small-shop owner finds as many ways to make a grinding wheel helpful as a Hooligan would find to make one exciting. And mind you, I am speaking of the simple apparatus found in all shops, which consists mainly of wheels and belts—not the "grinding machine" that is nine-tenths machine and only one-tenth wheel. On these simple appliances tools are ground, keys are fitted, castings are snagged, hurry-up jobs are surfaced, that which is too long is shortened, that which is too wide is made narrow, and that which is rough is made smooth. Yet in spite of its broad application, you find in many shops that grinding wheels are more abused than used.

The error that I will attack first, because it is the most common one, is the lack of running balance.

"What's that, an earthquake?" you ask as you feel the floor beginning to shake and tremble.

"Oh, no," is the reply, "it's just Tom starting up the grinding wheel."

One can hardly stand within ten feet of a grinding wheel in the average shop without feeling the vibrations running up and down his backbone. That this is an entirely unnecessary condition is seen when you consider that plain grinding machines with wheels running at the limit surface speed are practically free from vibration. They have to be, in fact, to produce accurate work. The result is not obtained by sleight of hand, but is due to three simple factors—a substantial base, true spindle and bearings, and well-balanced running parts.

The first essential of a smooth, quiet running wheel is a heavy frame. It is easier for a dog to shake a little tail than a big one. Some shop owners sidetrack the vibration question, in a manner shown in Fig. 1, by attempting to mount the grinding wheel on a springy frame, with the idea that it will absorb vibration. Considering the amount of work that is expected from a grinding wheel, it should not be begrudged a sufficiently heavy base.

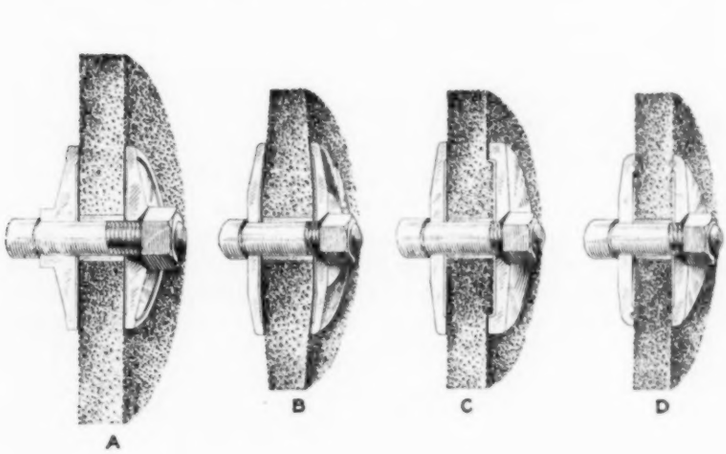


FIG. 3. FOUR METHODS OF MOUNTING GRINDING WHEELS

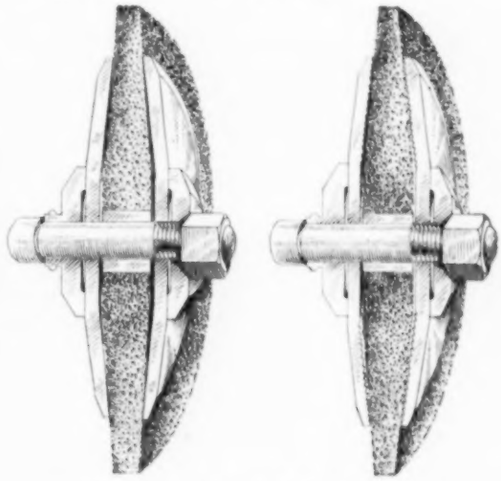


FIG. 4. SAFETY COLLAR MOUNTING

It is not uncommon to find shop owners with the idea that a grinding head may be shaken together out of the crudest kind of material. Bearings and spindles that are shaken together in this manner will continue to shake together as long as they last. The speed at which a grinding wheel must run requires not only a smooth, round, true and well-balanced spindle, but also bearings of the

most improved design, well lubricated and dustproof, and the spindle pulley must be carefully balanced.

"Shall I use a plain bearing or a ball-bearing grinder head?" This depends absolutely upon whether you will keep the wheel running true and in balance, or allow it to vibrate. Ball bearings on apparatus of this kind will save power, especially on wheels that are run idle a large part of the time. But there is no make of ball bearing that can possibly live under the hammering punishment of an unbalanced emery wheel.

Grinding wheels when received from their manufacturers are likely to be in good running balance; but as the density of the material in these wheels is not uniform, it is quite likely that after one of them is worn down an inch or two it will get out of balance. A means of quickly overcoming this is shown in Fig. 2. It consists of balancing flanges having light spots, which may be placed either opposite or together, or in any other relation to secure the desired counterbalancing effect. The use of such flanges is a mighty good scheme and saves time in making a wheel vibrationless.

While vibration is the most common defect of the grinding wheel, it is not the most important one, if the importance of these things is to be measured by their effects on safety. Bad wheel mountings and lack of guards have been responsible for more accidents than any other causes. I for one would much prefer to stand in front of a correctly mounted wheel running 10 per cent. overspeed than in front of a badly mounted wheel running 10 per cent. underspeed.

Clang! Clang!

"There goes the ambulance. Wonder what's the matter! Oh, it's old Bill from the Triumph Works—he's all smashed up. Emery wheel let go and hit him. They say it broke three ribs and tore off half of his face—mussed him up so you wouldn't know him. Oh, well, such things will happen. Say, ain't this war dreadful!"

Old Bill will spend the next two months in the hospital—if he is lucky or (unlucky) enough to live at all. When he comes out he will be as complete a wreck as any shrapnel-torn victim of bloody carnage. Bill's boss says the war should be stopped—that it's a shame for people to allow such things to happen nowadays. But why did *he* allow Bill to run his wheel without a guard and with flanges that were too small? That crime of negligence will stand against Bill's boss as black as many of the war-inflamed atrocities against those who in blind anger perpetrate them. You can't stop the war, Mr. Small-Shop Man, but you can make your grinding wheels safe! The old excuse that "My work won't allow of a guard" is getting threadbare and won't be presentable much longer.

Grinding-wheel guards have been illustrated so frequently in the columns of the *American Machinist* that I will not attempt to illustrate them here. All reputable makers of grinding stands equip them with guards, and if the stand is a home-made affair the guard can be also. Make the scroll out of ⅜ or ½-in. boiler plate, and bolt on side plate as an additional precaution. Keep the inside diameter of the scroll as near that of the wheel as possible, so that if a wheel lets go, it can't get far enough to work up much momentum.

There are certain principles in connection with mounting a grinding wheel which have been found by experience to lessen the risk of breakage. First, the bore of the wheel should be about 0.005 in. larger than the diameter

TABLE 1. MINIMUM SIZES IN INCHES OF MACHINE SPINDLES

Diam. in In.	Thickness of Wheel in Inches												
	¼	⅜	½	⅝	¾	1	1¼	1½	1¾	2	2½	2½	3
6	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜
7	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	½
8	⅜	⅜	⅜	⅜	⅜	⅜	⅜	⅜	½	½	½	½	½
9	⅜	⅜	⅜	⅜	⅜	⅜	⅜	½	½	½	½	½	½
10	⅜	⅜	⅜	⅜	⅜	⅜	½	½	½	½	½	½	½
12	⅜	⅜	⅜	⅜	½	½	½	½	½	½	½	½	½
14	⅜	⅜	⅜	½	½	½	½	½	½	½	½	½	½
16	⅜	⅜	⅜	½	½	½	½	½	½	½	½	½	½
18	⅜	⅜	⅜	½	½	½	½	½	½	½	½	½	½

of the spindle, or in other words, an easy fit. The inner flange should be fixed to the spindle, either being shrunk on and turned in place or mounted as a light drive on a sliding key. Both flanges should be recessed so that the wheel is grasped by the outer edges of the flanges. Blotting-paper gaskets should be placed between the flanges and the wheel, and the wheel itself should not be clamped too tightly. These principles apply to any one of the four methods of mounting, shown in Fig. 3, of which the most common are shown at *A* and *B*, being what are called the "straight" mounting and the "safety" mounting respectively. Unguarded wheels should be of the safety type, with flanges so large that the wheel itself does not extend over two inches beyond them. The use of these flanges, however, should not be taken as an excuse to do without a guard. The ideal scheme may be said to be to use both precautions, making doubly sure against accident. A well-known form of safety flange is shown in Fig. 4. It is the product of the Safety Emery Wheel Co., of Springfield, Ohio.

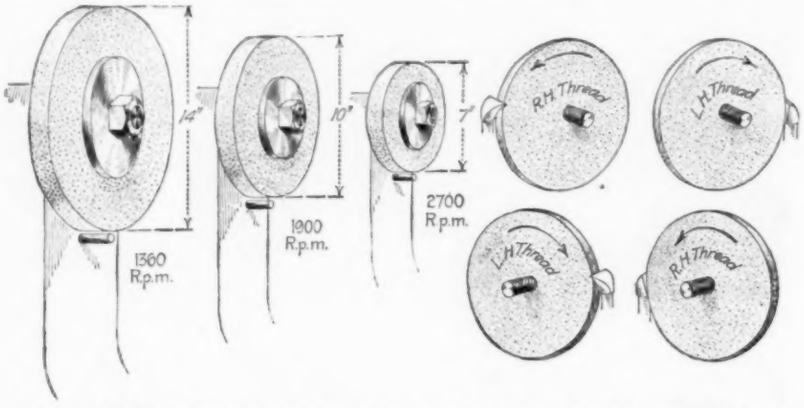


FIG. 5. KEEPING GRINDING WHEELS AT PROPER SPEED

FIG. 6. BE SURE THAT THE SPINDLE NUT TENDS TO TIGHTEN

TABLE 2. DIMENSIONS IN INCHES OF TAPERED FLANGES AND TAPERED WHEELS WHERE HOODS ARE NOT USED IN CONJUNCTION THEREWITH

a Maximum flat spot at center of flange. b Flat spot at center of wheel. c Minimum diameter of flange. d Minimum thickness of flange at bore. e Minimum diameter of recess in taper flanges. f Minimum thickness of each flange for single taper at bore.

Diam. of Wheel in In.	a	b	c	d	e	f
6	0	1	3	⅛	2	⅛
8	0	1	5	⅛	3½	⅛
10	0	2	6	⅛	4	⅛
12	4	4½	6	⅛	4	⅛
14	4	4½	8	⅛	5½	⅛
16	4	6	10	⅛	7	⅛
18	4	6	12	¼	8	1

Be sure that the wheel rotates in a direction that tends to tighten, and not loosen, the outer flange nut. Vibra-

tion will cause a nut to dance off of the end of the spindle if this precaution is not taken, and it is sometimes annoying to have to dodge the wheel that follows, or to repair the hole in the shop roof left by its exist. The illustration, Fig. 6, shows the proper thread to use for various rotations and hands of wheels.

Grinding wheels cut most efficiently at certain definite speeds, depending upon the grain, grade and use. Usually this speed is stamped upon the wheel by the makers, in terms of revolutions per minute. This does very well for a new wheel; but as work is done and the wheel is dressed, it becomes smaller in diameter, and while the

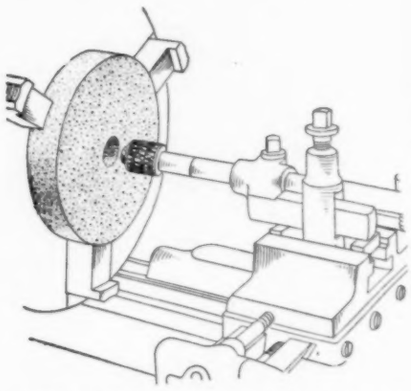


FIG. 7. ENLARGING THE HOLE IN A GRINDING WHEEL

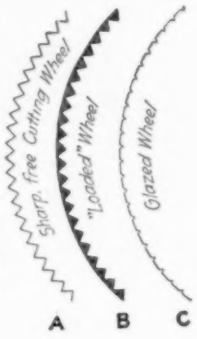


FIG. 8. THINK OF THE GRINDING WHEEL AS A CIRCULAR SAW

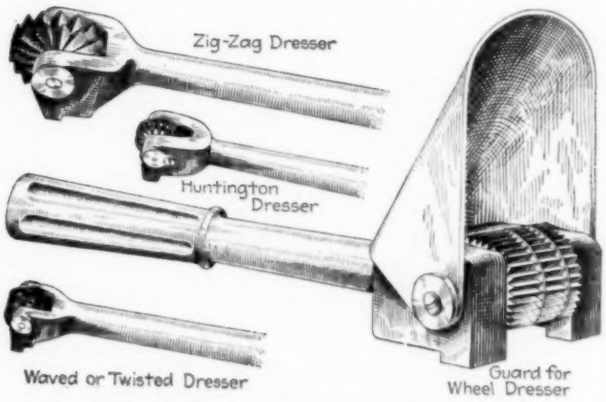


FIG. 9. PLENTY OF VARIETIES TO CHOOSE FROM

revolutions per minute stay the same the surface speed decreases and the wheel becomes less efficient. The scheme shown in Fig. 5 is a good one to overcome this drawback in a shop where two or more grinding stands are in operation. As the wheels become smaller, they are transferred to spindles of higher speed. Limit pins are used, as shown, to prevent getting on a wheel larger than is proper for the spindle speed.

A grinding wheel should be thought of as a circular saw. When the teeth are sharp and the cutting speed is right, it removes metal freely. Such a wheel is illustrated diagrammatically in Fig. 8 at *A*. A "loaded" wheel is shown at *B*, in which the teeth still remain but have their spaces filled with the material being ground, so that cutting is slow. A glazed wheel corresponds to a saw with its teeth ground away, and is shown at *C*. Very frequently the tendency of a wheel either to load or glaze may be overcome by running at a decreased speed. On the other hand, wheels which appear to be too soft are made to operate correctly by increasing their speed, taking care, however, not to exceed the safe limit.

There is no excuse for the small-shop owner pleading ignorance of good grinding-wheel practice. The Committee Report of the National Machine Tool Builders on grinding-wheel and machine safeguards was published in the *American Machinist* in Vol. 40 on p. 921. An elaborate table showing the causes of emery-wheel accidents was published in Vol. 39, p. 1060. On p. 129 of Vol. 42 a comprehensive "safety code" drawn up by a committee appointed by the abrasive-wheel manufacturers was presented to the readers. All three of these reports, modified and combined, were presented in one paper[1] at the recent annual meeting of the American Society of Mechanical Engineers.

TABLE 3. DIMENSIONS IN INCHES OF STRAIGHT FLANGES AND STRAIGHT WHEELS AND FOR SAFETY FLANGES USED WITH PROTECTION HOODS

A Diam. of Wheel in In.	B Minimum Outside Diam. of Flange	C Minimum Diam. of Recess*	D Minimum Thickness of Flange at Bore
6	2	1	¼
8	3	2	¼
10	3½	2½	¼
12	4	2½	¼
14	4½	3	⅜
16	5½	3½	⅜
18	6	4	⅜

* Recess to be at least ⅛-in. deep.

The following extracts are taken from this paper:

Before mounting, all wheels shall be closely inspected to make sure that they have not been injured in transit, storage, or otherwise. For added precaution, wheels other than of the elastic and vulcanite types should be tapped slightly with a hammer; if they do not ring with a clear tone they should not be used. Stamped wheels when tapped with a hammer may not give a clear tone. Wheels must be dry and free from sawdust when applying this test.

Wheel spindles shall be of sufficient length to permit of the nuts being drawn up at least flush with the end of the spindle, thus providing a bearing for the entire length of nut.

Protruding ends of the wheel arbors and their nuts shall be guarded.

Flanges, whether straight or tapered, must be frequently inspected to guard against the use of flanges which have become bent or sprung out of true or out of balance. If a tapered wheel has broken, the tapered flanges must be

TABLE 4. REVOLUTIONS PER MINUTE TO GIVE PERIPHERAL SPEED IN FEET PER MINUTE

Diam. of Wheel in In.	4,000	4,500	5,000	5,500	6,000	6,500
6	2,546	2,865	3,183	3,500	3,820	4,140
7	2,183	2,455	2,728	3,000	3,274	3,550
8	1,910	2,150	2,387	2,635	2,865	3,100
10	1,528	1,720	1,910	2,100	2,292	2,485
12	1,273	1,453	1,592	1,750	1,910	2,070
14	1,091	1,228	1,364	1,500	1,637	1,773
16	955	1,075	1,194	1,314	1,432	1,552
18	849	957	1,061	1,167	1,273	1,380
20	764	860	955	1,050	1,146	1,241

carefully inspected for truth before using with a new wheel. Clamping nuts shall also be inspected.

The work rest must be kept adjusted close to the wheel to prevent the work from being caught. Work rest must be rigid and always securely clamped after each adjustment.

A speed of 5,000 peripheral feet per minute is recommended as the standard operating speed for vitrified and silicate straight wheels, tapered wheels, and shapes other than those known as cup and cylinder wheels, which are used on bench floor, swing-frame and other machines for rough grinding. Speeds exceeding 5,000 ft. may be used upon recommendation of the wheel manufacturers, but in no case shall a speed of 6,500 peripheral feet be exceeded.

A wheel used in wet grinding shall not be allowed to stand partly immersed in the water. The water-soaked portion may throw the wheel dangerously out of balance.

Work shall not be forced against a cold wheel, but applied gradually, giving the wheel an opportunity to warm and thereby eliminate possible breakage. This applies to starting work in the morning in grinding rooms which are not heated in winter, and to new wheels which have been stored in a cold place.

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[1]Copies of this report may be obtained from the A. S. M. E. by mentioning its title, "Safety Code for the Use and Care of Abrasive Wheels," and inclosing 10c. with the request.

Machining an Eight V-Motor

By Robert Mawson

SYNOPSIS—In this article are shown the first operations used in machining the casting of an eight-cylinder V-type automobile motor. The operations in sequence are milling, drilling and boring.

On page 19 is shown and described the only single-casting, eight-cylinder V-type automobile motor made. It is a distinct departure in motor design and is the product of the Ferro Machine and Foundry Co., Cleveland, Ohio. This article is the first of three that will show all of the tools and operations in machining the cylinder casting. The first operation is milling the parting-line surfaces. Afterward two holes are drilled and reamed in the parting-line flange. These holes, by means of pins are used for locating the other tools.

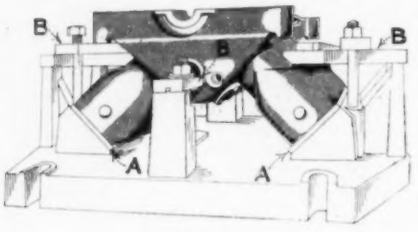


Fig. 1

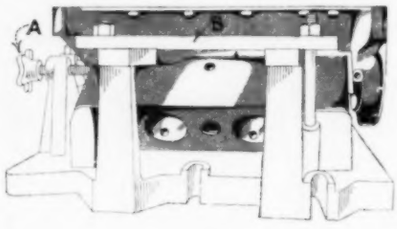


Fig. 2

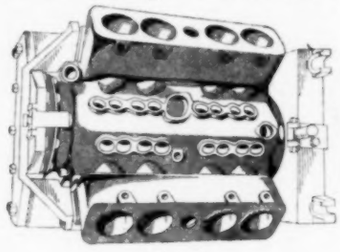


Fig. 3

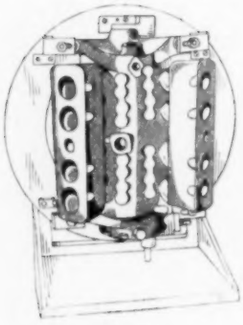


Fig. 4

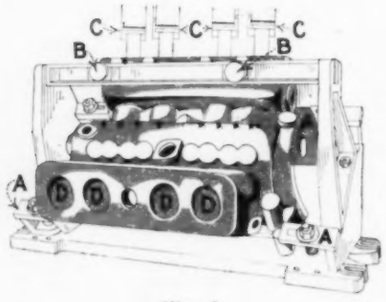


Fig. 5

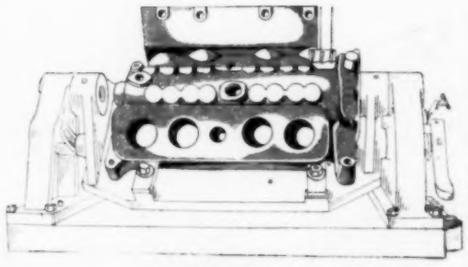


Fig. 6

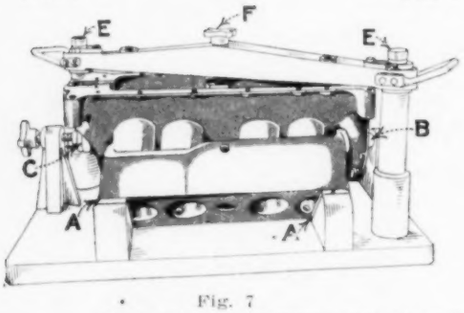


Fig. 7

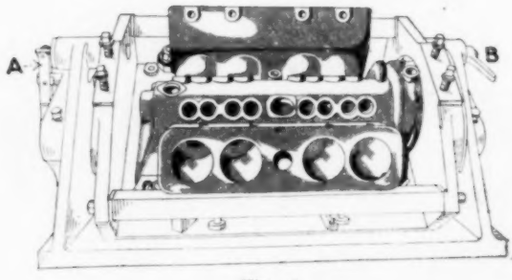


Fig. 8

JIGS AND FIXTURES FOR EIGHT-CYLINDER V-MOTOR WITH PIECES IN POSITION

Figs. 1 and 1-A

Operation—Milling parting line of cylinder. Located on steel pads A on angular surfaces previously machined. Straps B are then slid on the casting and nuts tightened to hold the part securely, three fixtures being used at once. Use 16-in. inserted cutter; speed, 16 r.p.m.; feed, 0.19 in. per revolution.

Figs. 2 and 2-A

Operation—Milling cam gear-housing surface on cylinder. Placed on steel pads and located by the knob screws A. Held down with straps on each side, as B. Use 10-in. inserted-tooth cutter at 65 r.p.m., 0.13 in. per revolution.

Figs. 3 and 3-A

Operation—Machining locating holes in cylinder placed on steel pads A, forced back against locating plugs B with screw C. Cover D dropped on posts held with open washers and knurled nuts E. Knob screw F tightened on casting to hold it in position.

Holes Machined—Two $^{33}/_{64}$-in., drilled, then reamed to $\frac{17}{32}$ in.

Figs. 4 and 4-A

Operation—Drilling holes in cylinder at cover end. Casting located by two pins that fit into reamed holes; two straps then tightened to hold the part in position.

Holes Machined—Six ¼-in. drilled which are later tapped with $\frac{5}{16}$-in. U. S. F. threads.

Figs. 5 and 5-A

Operation—Drilling for oil tube. Cylinder located by two pins set in reamed holes and held in position with four straps.

Holes Machined—One ½-in. to suit tube and one ¼-in.

Figs. 6 and 6-A

Operation—Milling small bosses. Casting located by two pins fitting in reamed holes and held in place with four straps. Positions determined for various machined surfaces by index pin A fitting in bushed hole and operated by a lever.

Surfaces Machined—Valve and water-intake pads, using 2-in. mill; speed, 145 r.p.m.; feed, 0.04 in. per revolution.

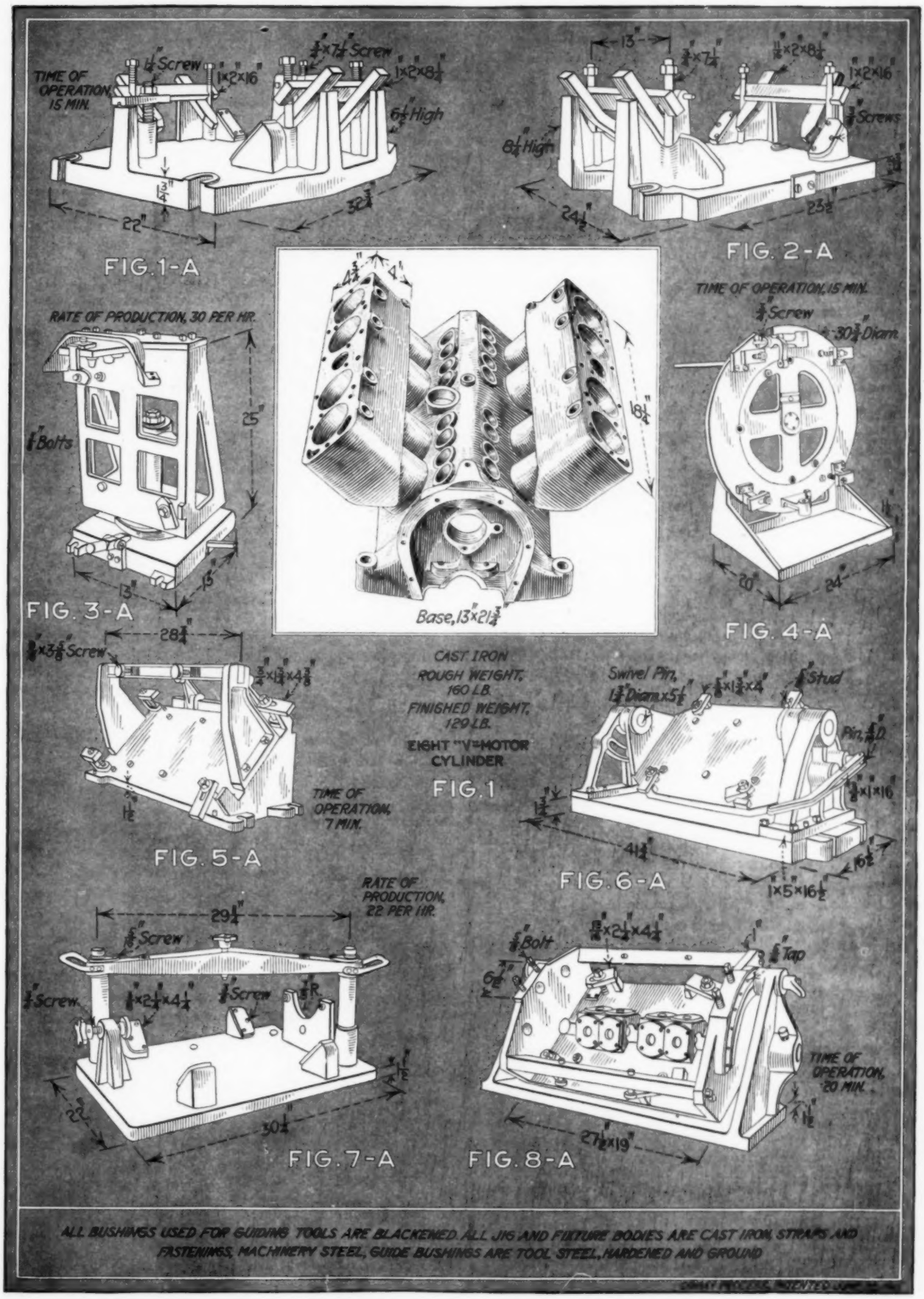
Figs. 7 and 7-A

Operation—Rough-boring cylinder. Casting located by two pins fitting in machined holes, held in place with four straps, as A. Screws B tightened to assist in holding them. Holes rough-bored with tools C. Casting taken out, turned 180 deg., relocated, and four holes D bored.

Holes Machined—Eight bores.

Figs. 8 and 8-A

Operation—Finish-boring cylinder casting, located by two pins fitting in reamed holes, then held down with four straps. Position obtained with index pin operated with the lever A and locked with the handle B. Four holes are bored to size, the tools being piloted in hardened bushings at the lower end.



DETAILS OF JIGS AND FIXTURES USED IN MACHINING 8 CYLINDER V-MOTOR

Getting Paid for Knowing How

By W. D. Forbes

Ira Clark was a Down-Easter. He came from somewhere in the State of Maine and had been working for O. B. Jennings for a number of years. He was a real machinist, not one of the old-time talkative type who is always telling how much more he knows than the foreman or boss, but an old workman right up to date. His tool box had the very latest styles of micrometers, depth gages and all the other obtainable new tools. One of his peculiarities was that he never seemed to do a job like anyone else, and seemingly took pride in this.

Jennings used to offer work to his men at a fixed price, so much for the job, and they always made big money at it. One day three or four barrels of brass circular disks came into the shop, and Ira got the job of doing the machine work on them. The disks were a little over $\frac{1}{16}$ thick, the largest being $2\frac{1}{2}$ in. in diameter and the smallest one $1\frac{1}{2}$ in. They all had a $\frac{5}{8}$ hole that had to be reamed. All the diameters varied, and they had to be exact. I think they were used for a train of gears, but I am not sure. Anyway they were ordered in sets, and Ira took them at so much a set. The first thing he did was to plane up a shallow V-block large enough in the angle to take the largest disk. This he used to center the various sizes of disks for drilling and reaming.

He hired a young lad to do this work, but very much to our surprise he did not drill all of one size of disk at a setting, but shifted about every two hours. While the lad was doing this shifting and reaming work, Ira made three arbors out of tool steel, like Fig. 1, also some steel disks a trifle smaller than the diameter of the various brass disks that had to be turned. Of course he hardened the ends of these arbors and fitted a nut to them; then he fitted up a plate of cold-rolled steel, which was an inch thick, for a tool holder. The tools were pieces of $\frac{5}{16}$-in. drill rod and were held in place in the tool holder by setscrews, as in Fig. 2. By the time he got the tools and arbor ready the boy had drilled and reamed a lot of blanks. These Ira slipped on the arbor, putting five disks of each size, together with the steel spacing disks between them, and drew them up solid with the nut. Then he bolted his tool holder to the carriage of his lathe, packing it up to the proper height and setting each tool so as to finish the disks to their proper diameter. By this method five sets of disks were finished on each arbor, and the boy was kept busy filling the two spare arbors while Ira turned the off disks.

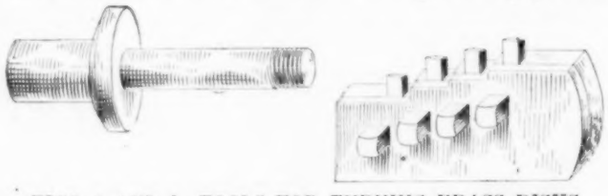
Another peculiar thing about Ira Clark was that he made money whenever he got the chance, and he never let a chance slip. We boys questioned him as to the value of doing this job I have described and suggested that he would have saved making his multiple tool post by machining one size of disk complete and then taking up another size. Ira admitted this, but rather chuckled to himself when he said that he would make more money that way. This astonished us, but we got on to the idea a few days later.

It seems that the man who had ordered the work came into the office in great trouble, as he had to have some of the set of disks at once and could not wait until each size was machined up. So Ira was sent for by O. B. to find out how much more it would cost to break up and get out some sets in a hurry.

Ira shook his head and looked very thoughtful, and it was finally agreed that he was to get 20 per cent. more on his contract if he could get out 50 sets in the next three days. If he could work overtime and get out the 50 sets by the next evening there was an extra five-dollar bill in it for him. Ira did not work overtime of course, but the man got his disks and we questioned Ira as to the fairness of the transaction.

"Well," said he, "I look at it this way. My hair is gray and I am getting old. I would have a mighty hard time getting a job if I lost this one. The years that have gone have taught me something, and I think I have the moral right to use the knowledge which those years have given me. O. B. Jennings got his money, and I did him no injustice. The customer got his work when he wanted it and was satisfied. I got more money because my experience had taught me that when a job like this one comes along, part of it is always wanted in a hurry. I simply used my brains to meet conditions, and I asked pay for it. A banker does not lend money without getting interest on his capital, and my capital is my brains and hands; but most machinists seem to use only their hands when it comes to making money."

Several months after this, O. B. Jennings put in three automatic screw machines and got a big job for



FIGS. 1 AND 2. TOOLS FOR TURNING BRASS DISKS

them. A demonstrator came down and started them up. All went well for a while until trouble arose from the stock running bad. Some of it worked up as nice and smooth as could be desired, then a bar would be found that worked so rough that if you tried to wipe it off with a piece of waste it would look like a woolly lamb. The man who sold the stock could not account for it, and the trouble continued for about a week; but after that all the work came out nice and smooth.

This is what had happened. Ira had watched the trouble, and after the salesman had come over to investigate once or twice, Ira told him that for fifty dollars he would show him how to overcome the difficulty. In a very few days the troubles ceased. Ira got his fifty.

The cure was so simple that when we found out what had occurred we thought that Ira's price was pretty high, but there again Ira contended that "know how" should be paid for. All Ira did was to tell the salesman to have the operator of the screw machines, if a bar started to cut rough, take it out and reverse it; and that did the trick every time. We did not get the philosophy of the thing at all, so we asked Ira about it.

He took a lead pencil from his pocket and opening his knife, started to sharpen the pencil in the usual way, that is, cutting from the outside toward the lead. This made a nice smooth surface; but when he reversed the operation and tried to cut from the lead toward the outside, he cut against the grain and got a rough result.

"Of course," Ira said, "there are materials which do not act in this way, but I have found that very often stock cuts better when it is fed to the tool in the direction in which it is drawn.

Metal-Working Machine Market in Switzerland

By Ludwig W. Schmidt

SYNOPSIS—The war has brought great industrial handicaps and economic hardships to Switzerland. Cut off from natural European markets both for the purchase and the sale of commodities, she has to turn to the United States for materials and machines. The Swiss demand for machine tools has been greater than ever before and seems destined to continue throughout the period of the war.

The export of American metal-working machines to Switzerland was not large during the second half of 1914 and the first half of 1915. For several months, however, an increase has been noticed, and some manufacturers say that they have recently received larger orders for metal-working machines for the account of Swiss buyers than ever before. This confirms information from Switzerland to the effect that the country has undergone a considerable change in her economic conditions and now seems ready for a forward movement.

Switzerland has suffered greatly from the war. The little republic has been completely hemmed in by the fighting nations and consequently has not been able to develop on a scale in keeping with former years. For some time it looked as if the war would create a serious economic crisis. This danger is now gone, happily, and manufacturers are beginning to make ready for the coming business revival. In addition to these hopeful signs comes the influence of the economic isolation which the country has suffered since the outbreak of the war. Switzerland has not only been cut off from some of her best markets, but she has also been unable to buy many things which she has been accustomed to obtain from abroad. For instance, the large imports from Germany, France and England failed nearly entirely.

It has taken some time for the country to accommodate itself to the new conditions and to begin to make some goods which were withheld from it by the war. The most difficult problem of course has been the feeding of its population. With the coming of the harvest of the past autumn and through agreements with the warring nations, this situation seems to have been greatly relieved.

Switzerland's Difficulty in Getting Manufacturing Supplies

Another difficulty that has retarded a revival of industrial enterprise has been the unwillingness of the nations around the republic to let her have any sort of industrial supplies, owing to the danger that they might reach an enemy by way of Switzerland. This restriction has affected the trade of the republic in many directions. The formation of a Swiss Foreign Trade Trust of the same character as like institutions in Holland, Norway and other countries has removed this distrust, and Swiss manufacturers can now buy their supplies direct. The only marked difficulties remaining are those of labor and transportation. As there is the continual danger that parts of the contending armies on both fronts may enter Swiss territory, Switzerland must keep part of her army mobilized, to secure her neutrality against any transgression. Further, she has to rely on the good will of all the countries around her for the transportation of her outgoing goods as well as of those destined for her. France has done her best to secure an outlet for the trade of the small republic, but this outlet has been frequently interrupted, and even now complaints are heard about lack of car facilities. One cannot expect the French railways to take overmuch trouble with that sort of traffic when transportation facilities are urgently needed for other purposes.

American manufacturers wishing to ship to Switzerland ought to consider carefully the traffic conditions, so that they will not see their goods held up unnecessarily by consigning them to crowded ports. As a rule the shipper is able to advise on this point.

Switzerland as a Buyer of Metal-Working Machines

Switzerland, according to her own statistics, is not a large buyer of foreign metal-working machines. Only $1,250,000 worth enters the country yearly. The reason for this is that she is well able to take care of a large part of her own consumption. Swiss metal-working machines are of good quality and of course especially designed and constructed for the needs of the market. Also Switzerland has even been able to keep quite a respectable export business in comparison to the country's industry, sending every year to foreign markets metal-working machines of a value of about $500,000.

The demand for machinery, however, is not limited to metal-working machines. In fact Switzerland is a considerable buyer of many classes of machines. The extent of that trade is best shown by the accompanying list, giving the imports for 1914 and 1913. Of course the figures for the last year are rather misleading and may tend to discourage American manufacturers.

SWISS MACHINERY IMPORTS

	1913	1914
Boilers of iron and steel	$464,260	$364,160
Boilers of other metals	29,040	21,460
Spinning machines	450,200	231,540
Looms	80,300	594,460
Weaving machines	113,820	87,000
Knitting machines	70,840	49,600
Embroidery machines	273,380	55,740
Sewing machines	495,480	272,040
Printing machines	492,820	310,540
Agricultural implements	143,320	122,280
Agricultural machines	406,100	316,620
Electrical machines	308,560	274,960
Paper machines	283,080	266,640
Flour-milling machines	36,980	26,480
Waterwheels	149,100	92,980
Steam prime movers	130,280	98,800
Metal-working machines	1,240,850	825,040
Other machines	2,373,400	1,657,660
Automobiles	1,820,000	1,520,000
Locomotives	62,800	98,880
Internal-combustion motors	101,940	108,000
Brick-making machines	213,620	290,980

Only the last three classes show an increase. The small gain in the import of internal-combustion engines has most likely continued, because Switzerland has a well-developed automobile-building industry that has prospered during the war. Not only have large orders been received from the Swiss Government for cars for mobilization purposes, but the exports of motor cars were fairly

large to Germany, France and Austria during the beginning of hostilities. The influence of the war on automobile exports can be easily seen from the fact that the sale of chasses has increased from $921,400 in the first half of the year 1914, that is, before the war, to $1,738,000 in the second half.

Exports and Home Consumption of Swiss Machines

Not all of the machines imported by Switzerland can be supplied conveniently by the United States. Many of them are machines for special purposes, the sale of which depends upon the industrial methods employed; for example, some of the knitting, weaving and lace-making machines. In fact in many of these machines Switzerland has been able to develop types of her own which are in demand in other countries.

Switzerland has a fairly large machine-building industry, considering the size of the country, and her manufacturers had developed the industrial possibilities of the market rapidly during the years immediately before the war. The import of boilers, for instance, is small in comparison with the number made at home. There is a highly developed industry for lace-making and knitting-machine manufacture. Agricultural machines and printing presses are also built. In printing machines the country has been able to produce a product of international fame; the agricultural machines find their sales mostly in Switzerland itself. Her internal combustion engines are widely exported and sell readily, for they are of good construction. Further, there must be mentioned the electrical industry of the country. One of the largest electrical enterprises of the world is located in Switzerland, and the import as well as the export of electrical machines is large. This latter industry finds good support in consequence of the geographical position of the country, which is very favorable to hydro-electric developments.

All of these industries have exported, and the importance of their foreign trade may be seen from the table herewith.

EXPORTS OF SWISS MACHINERY

	1913	1914
Automobiles	.....	$2,659,400
Boilers of iron and steel	$391,500	212,380
Boilers of other metals	63,520	62,700
Spinning machines	467,604	387,200
Looms	936,280	875,640
Weaving machines	566,060	372,300
Knitting machines	325,940	285,180
Lace machines	550,460	373,920
Electrical machines	4,070,600	3,115,660
Flour-milling machines	1,650,800	1,238,900
Steam engines	2,098,840	1,180,000
Internal-combustion motors	2,181,180	1,750,060
Metal-working machines	487,740	476,060

The export of all those machines has been reduced during the last year, and in every case the reduction can be traced to the influence of the war.

Sudden Demand for Machines Has Come as a Result of the War

The sudden demand for all kinds of machines from Switzerland, especially for metal-working machines, seems to have come as a surprise to many American manufacturers. Those who knew the economic conditions there can, however, hardly be surprised at this development, as the country has been practically starved of her machine imports during the past twelve months. How serious the effect of the war must have been on the regular supply of machines can be seen best from statistics supplied by the Verein Schweizer Maschinen Industrieller (Union of Swiss Machinery Builders) which compare the records of the first and the second half of the year 1914 and were made especially to show the effect of the war. The tabulation shows that the whole import of machines was cut to about half the normal amount in the second half of last year, and leaves no doubt that the Swiss manufacturers must have felt the shortage very seriously.

This association includes the leading machinery builders of Switzerland and has 154 members, employing 36,123 workmen. Most of its members are in or near Zurich, although the Canton of Berne is another important industrial center. The Swiss market is not very difficult to work, and in many cases manufacturers have relied on agencies in southern Germany or Paris for this business. An agent of course has better facilities for studying the demands of the market while in its center, and Zurich is possibly the best location for establishing a local agency.

Prospects for Sale of Machinery in Switzerland in the Immediate Future

Undoubtedly there is much business just now to be had in Switzerland. Whether this will hold on is difficult to say. There are several industries, as the famous Swiss silk and the lace making, which export to the whole world. But much of the prosperity depends upon the so-called travelers' industries—hotels, summer resorts and the like.

Should the available wealth of Europe be seriously curtailed, this would mean that Europeans would not visit Switzerland as much as before, and such an event would spell ruin for a large percentage of the Swiss population. Consequently nobody can wish more fervently for an early end of the present struggle than the Swiss.

As regards metal-working machines at present, it seems that very little choice is left to Switzerland other than to buy in this country as long as the war lasts. Neither of her former suppliers is able to care for her wants. Before the war Germany had the lion's share in Swiss imports of metal-working machines, supplying about $750,000 worth annually. The imports of American machines had not been so large but were increasing. In 1914 there was $22,627 worth of metal-working machines exported by the United States to Switzerland. This figure has been greatly exceeded during 1915, with prospects of still larger sales in 1916.

One Way To Avoid Breakage of Center Drills

By Gilbert J. Marion

When a combination drill and countersink breaks off in the work it is usually difficult to take it out. The breakage is generally caused by the drill part binding. If this is ground off center as shown, one lip will be

AVOIDING BREAKAGE OF CENTER DRILLS

longer than the other and will cut a hole larger than itself and seldom break. Sometimes through careless feeding the point will break off, but even then it will be found to be free in the work and will come out easily.

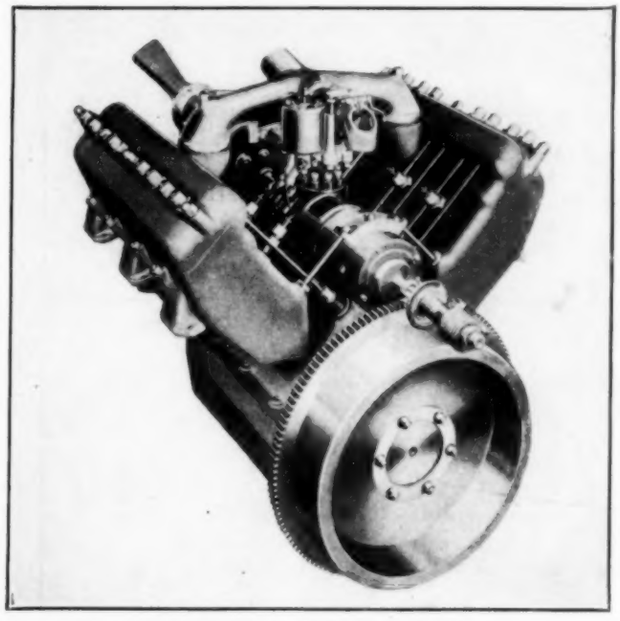
The Ferro Eight V-Motor

On page 14 is printed the first of a series of articles describing the tools and methods used in manufacturing the eight V-motor shown in the illustration.

This cylinder is made with what is on four- and six-cylinder motors the cylinder and upper crank case cast in one part. This arrangement lends itself admirably to a simplification of the manufacturing operations, as the bases and other surfaces may be machined easily.

The lower crank case, or oil pan, is a light pressed-steel stamping. The motor is what is known as valves-in-the-head-type motor and is carried in a separate casting attached to the cylinder. Over this is fastened the cylinder-head cover, which carries the separate plugs.

The valves are operated by a camshaft fitted with 16 integral cams through roller-valve lifters. The bore of



THE FERRO EIGHT V-MOTOR

the cylinders is 3 in. and has a 3½-in. stroke. The crankshaft and the camshaft are each fitted with three bearings of sufficient diameter and length to insure the desired rigidity. Recently one of the motors was given a 300-hr. endurance test, which was equivalent to a car traveling 35 mi. per hr. at a motor speed of 1,500 r.p.m. for a distance of 11,000 mi.

After the test the parts were examined and measurements taken. In every case the wear was inappreciable, the greatest wear being on the connecting-rod bearing, which was only 0.0008 in. The main bearings showed a wear of 0.0004 in. The construction was babbitt against the crankshaft for the connecting-rod bearing and a hardened-steel connecting-rod against phosphor bronze for the middle bearing of the rod.

Charts for Strength of Gear Teeth--Marx Formulas

By John B. Peddle*

The most recent investigations into the strength of cast-iron gear teeth have been made by Guido H. Marx and Lawrence E. Cutter. The main purpose of the study was to determine the effect of an increase of pitch-line velocity upon gear-tooth strength. The first series of experiments, reported to the American Society of Mechanical Engineers by Professor Marx in 1912, covered speeds up to 500 ft. per min. The second series, reported by the investigators jointly in September, 1915, extended the range to 2,000 ft. per min. This latter paper was reviewed editorially in Vol. 43, p. 610.

The summary of these studies gives two formulas—the first for the strength of cast-iron, Brown & Sharpe, 14½-deg. involute gear teeth; the second for cast-iron Fellows, 20-deg. involute, stub gear teeth. Tables are also included for two of the factors—*v*, the velocity coefficient, and *a*, the arc-of-action coefficient.

These formulas are somewhat complex, as each contains seven variables. To increase the ease of their use in the hands of designers, each has been plotted in the form of a full-page alignment chart (see Charts 1 and 2). Following the customary arrangement, the original formula and a brief explanation of how to use the chart accompany each.

The notation for the formulas follows:

W = Safe equivalent load at pitch line, pounds;
s = Modulus of rupture = 36,000 lb. per sq.in. for cast iron;
p = Circular pitch, inches = pitch arc;
f = Width of face of gear, inches;
n = Number of teeth in gear;
k = Factor of safety;

Suggested values: $k = 4$, for steady load, no reversal of stress;
$k = 6$, suddenly applied load, no reversal of stress;
$k = 8$, suddenly applied load; with reversal of stress.

v = Velocity coefficient (see tables);
a = Arc-of-action coefficient (see tables).

The tables for v and a are also given, although these values are plotted on their proper scales on the charts.

VALUES OF v

Pitch-Line Velocity, Ft.-Min.	v: Brown & Sharpe 14½-Deg. Involute	v: Fellows 20-Deg. Involute Stub Tooth	Pitch-Line Velocity, Ft.-Min.	v: Brown & Sharpe 14½-Deg. Involute	v: Fellows 20-Deg. Involute Stub Tooth
0000	1.000	1.000	1100	0.470	0.540
100	0.795	0.825	1200	0.455	0.525
200	0.730	0.755	1300	0.445	0.515
300	0.675	0.705	1400	0.435	0.505
400	0.635	0.665	1500	0.430	0.495
500	0.595	0.635	1600	0.420	0.485
600	0.565	0.615	1700	0.415	0.475
700	0.540	0.595	1800	0.410	0.470
800	0.520	0.580	1900	0.405	0.460
900	0.500	0.565	2000	0.400	0.450
1000	0.485	0.550	....	....	....

VALUES OF a

Number of Teeth in Engaging Gears	Corresponding a: Brown & Sharpe 14½-Deg. Involute	Corresponding a: Fellows 20-Deg. Involute Stub Tooth
Single tooth engages	1.00	1.00
12	1.10	1.12
20	1.15	1.20
30	1.47	1.22
30	40	1.60	1.24
30	60	1.60	1.25
30	80	1.60	1.26
30	100	1.60	1.27
30	Rack	1.60	1.29
100	100	1.60	1.31
100	Rack	1.60	1.33

In using these charts in design, it should be borne in mind that the experiments on which they are based were made with cast-iron gears only and with small pitches—10 diametral pitch in the case of the Brown & Sharpe gears and 10/12 diametral pitch in the Fellows gears.

*Professor of machine design, Rose Polytechnic Institute.

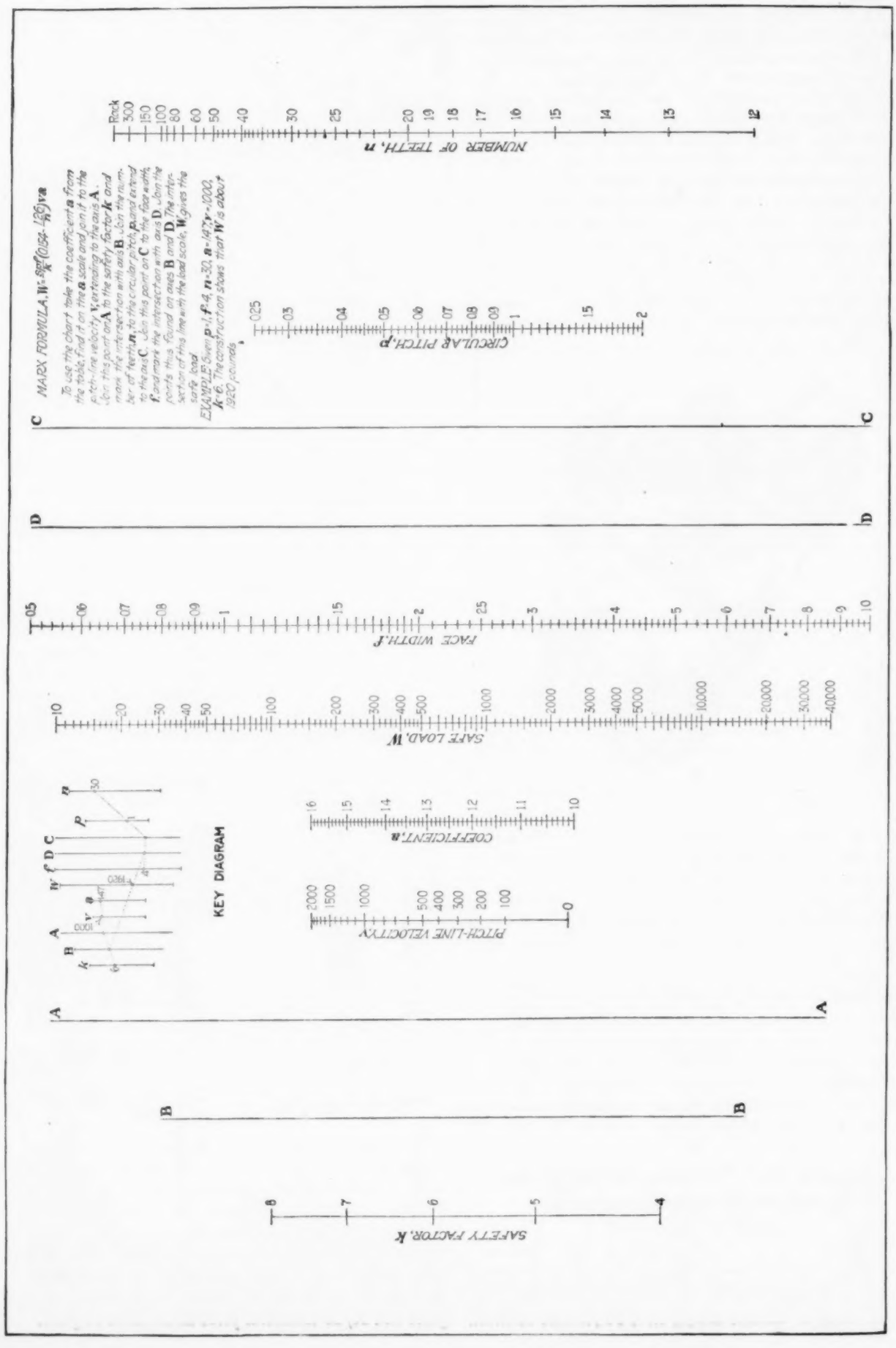

MARX FORMULA. W = s f (0.134 - 1.26/n) v a
To use the chart take the coefficient a from the table, find it on the a scale and join it to the pitch-line velocity, V, extending to the axis A. Join this point on A to the safety factor k and mark the intersection with axis B. Join the number of teeth, n, to the circular pitch, p, and extend to the axis C. Join this point on C to the face width, f, and mark the intersection with axis D. Join the points thus found on axes B and D. The intersection of this line with the load scale, W, gives the safe load.
EXAMPLE: Given p = 1, f = 4, n = 30, a = 147, v = 1000, k = 6. The construction shows that W is about 1920 pounds.
NUMBER OF TEETH, n
CIRCULAR PITCH, p
FACE WIDTH, F
SAFE LOAD, W
KEY DIAGRAM
COEFFICIENT, a
PITCH-LINE VELOCITY
SAFETY FACTOR, k

CHART 1. SAFE LOADS ON CAST IRON, BROWN & SHARPE, 14½-DEG. INVOLUTE GEAR TEETH

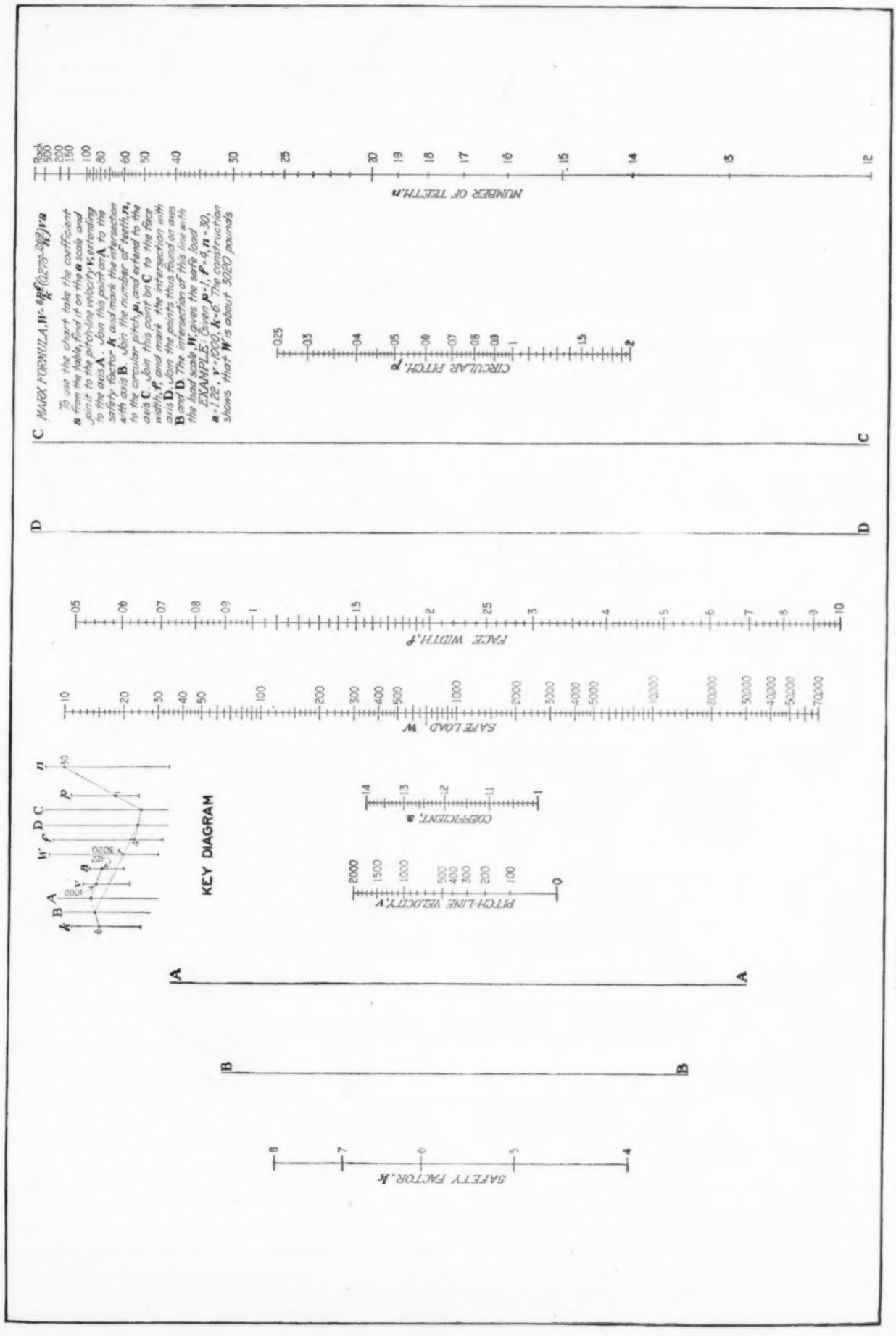

MARX FORMULA, W = 6Pf (0.278 - 3v/1000) / k
To use the chart take the coefficient a from the table, find it on the a scale and join it to the pitch-line velocity V, extending to the axis A. Join this point on A to the safety factor k and mark the intersection with axis B. Join the number of teeth, n, to the circular pitch, p, and extend to the axis C. Join this point on C to the face width, f, and mark the intersection with axis D. Join the points thus found on axes B and D. The intersection of this line with the load scale, W, gives the safe load.
EXAMPLE: Given P = 1, P = 4, n = 30, a = 1.22, v = 1000, k = 6. The construction shows that W is about 3020 pounds
NUMBER OF TEETH, n
CIRCULAR PITCH, p
FACE WIDTH, f
SAFE LOAD, W
COEFFICIENT, a
PITCH-LINE VELOCITY, V
SAFETY FACTOR, k
KEY DIAGRAM
A
B
C
D

CHART 2. SAFE LOADS ON CAST IRON, FELLOWS, 20-DEG. INVOLUTE GEAR TEETH

Effective Hand Wire Benders of Various Types

By F. C. Mason

In manufacturing plants where springs are used that are made of wire, and not in sufficient quantities to warrant an automatic machine, the hand bender is employed. These benders make from 1,000 to 20,000 springs per day. The amount varies with the size of wire and the number of operations. This article will describe and illustrate some of the elementary bends and simplified methods of making them.

There are three movements that may be used to produce almost any shape. These turn, brake and form with a die. The die may be actuated by hand power or in a punch press.

There are a great many ingenious machines made embodying a combination of these movements. Fig. 1 is a view of a simple machine with which to make a spring with two extended ends, each spring having one or more tension coils. The spring is shown at *E*.

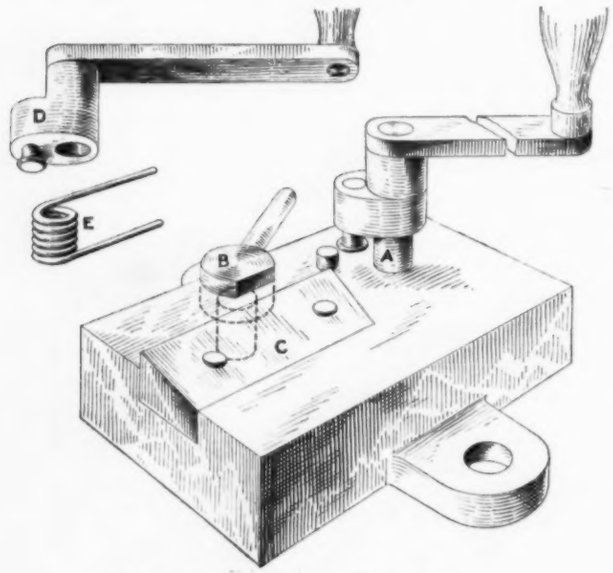


FIG. 1. SIMPLE SPRING BENDER

A is the forming pin, *C* the clamp stop and *B* the clamp. With this bender the handle shown at *D* can be used satisfactorily.

The stop which gages the length of wire for the start is not shown. The wire is slipped into the clamping device against the stop, is clamped and the desired number of turns made with the handle, which wraps the wire around pin *A*. This pin should be made of tool steel hardened and drawn down to a blue color, leaving it hard enough not to dent and still as strong as possible. The clamping device should also be hardened.

Figs. 2 and 3 show two forms of brake for bending wire at an angle. They are both made on the same principle, but their adaptation for this purpose makes a great difference in the output. The brake is at *A*; *B* is the brake block and *C* the slot to hold the wire. It is obvious that by changing the side of the form any angle from 30 to 45 deg. can be produced. This brake principle is very useful in wire-bending machines and can be used in many combinations. The bends shown at *D* are made by this bender.

Fig. 4 shows another modification of this principle which I believe is original. This bender bends simultaneously two right angles, as shown at *B*.

There are two brakes *AA* working right and left, actuated by one lever or handle *C*. These two brakes mesh

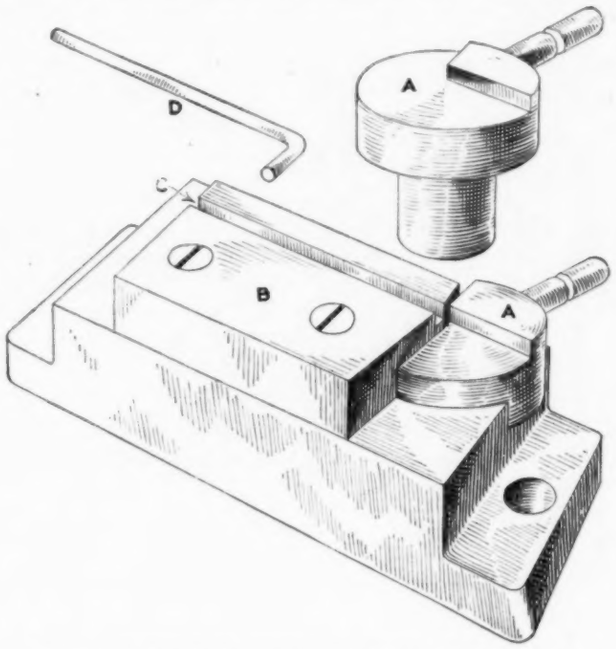


FIG. 2. BRAKE FOR BENDING WIRE AT AN ANGLE

together, using gear teeth to actuate the one opposite the handle. I have used one of these for several years for bending No. 12 door-spring wire that was only $\frac{13}{32}$ in. on the inside. The gear segment was $\frac{5}{8}$ in. in outside diameter, using a 20-pitch cutter to cut the teeth.

Fig. 5 shows a form of bender made to produce the hook shown at *H*. With this type of bender one can

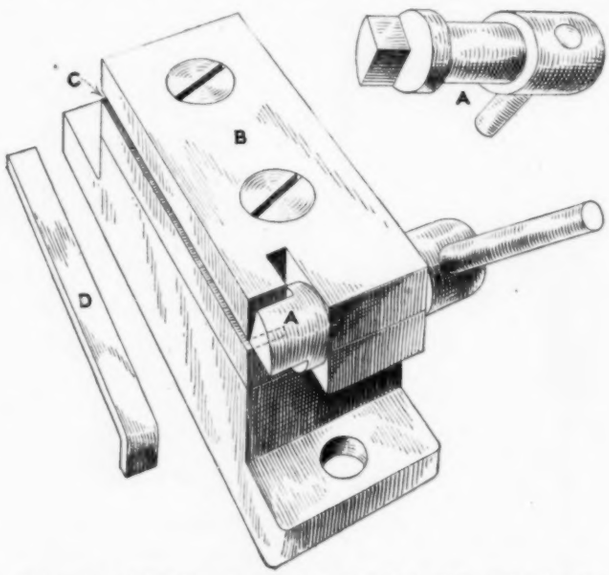


FIG. 3. ANOTHER VIEW OF BRAKE FOR BENDING VARIOUS WIRE ANGLES

make rapidly almost any shape of flat work, all the bends being made on one block. It is only a question of having the pins of the proper size, located in the right place, and of handles to fit for the desired turns. The design shown will exemplify the principle. Handles similar to

that illustrated and at *D* in Fig. 1 should be used with this bend.

The wire is placed between the pins against the stop *A*, and with the handle shown in Fig. 1 the wire is bent out as indicated by the dotted lines *C*. The eyelet is

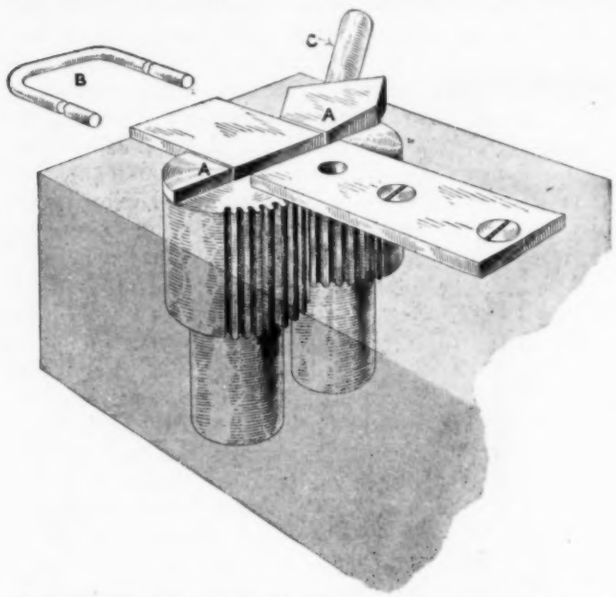


FIG. 4. MACHINE FOR BENDING TWO RIGHT ANGLES

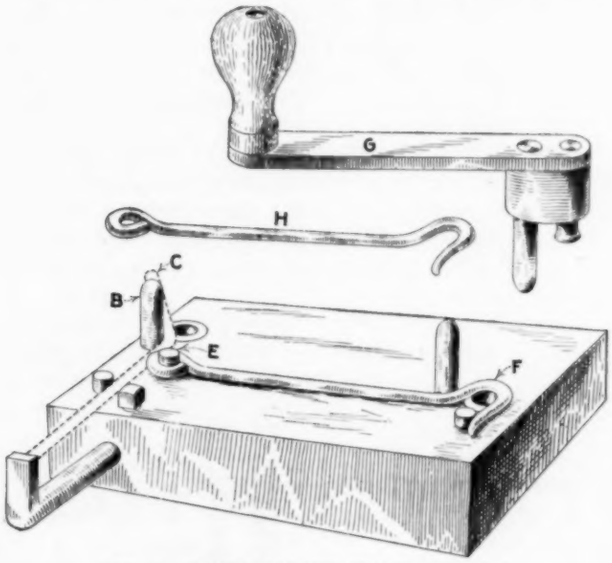


FIG. 5. RAPID-ACTION HOOK BENDER

completed with the handle *G*. Next is taken the wire with the eyelet and the eyelet put over the pin for a gage. The first operations are then repeated, which produces the hook as shown in position at *F*. Benders made in this manner are cheap and efficient.

20-In. Faceplate on 10-In. Lathe

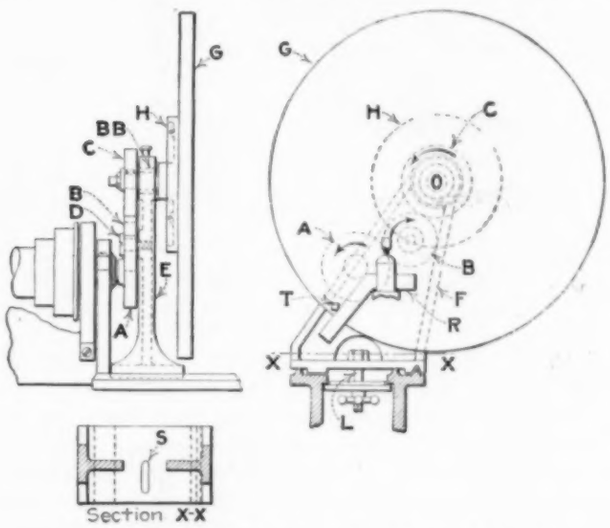
By Martin Fogel

The great variety of work which falls to the lot of the average job or experimental shop compels it to make use of all sorts of makeshifts to turn out the work without a prohibitively large equipment.

One job which fell to our lot gave promise of repeat orders and was therefore valuable enough to take pains with. We had to produce a large quantity of 18-in. fiber and brass rings from $\frac{1}{16}$-in. stock.

The only available lathe was one with a 10-in. swing. It was out of the question to have the rings done outside, as we wanted that work ourselves, so I designed the fixture shown in the illustration. It has served the purpose first rate and has been of use on other similar work. It increases the swing from 10 to 20 in. It is not suitable for heavy work, though that is but a matter of proper construction.

The frame is a casting *F*, machined on the bottom as shown and has a V groove to fit one way on the lathe bed. The long slot *S* allows the bolt *L* to be dropped through from the top. The gears *B* and *C* are a pair of standard change gears of the lathe. Gear *C* is keyed to the spindle of the faceplate *H*. Gear *B* acts as an idler and direction changer for the gear train. The stud *D*



LARGE FACEPLATE FOR A SMALL LATHE

is screwed into the boss cast on the frame. Gear *A* is made from an old faceplate and screws on the headstock spindle in the usual way.

To use the fixture, the frame *F* is placed on the way as shown, with the gears *B* and *A* in proper mesh, and fastened with the bolt. To the faceplate *H* is attached the 20-in. wood disk *G*, on which the work is mounted.

The tool rest *R* is a bar of machine steel bent so as to bring its upper edge parallel with a line passing through the center *O*. This is necessary to prevent the hand tool shown by the section *T* from digging into the work. The working end of *R* is really very short, being limited by the tool carriage, but for the sake of illustration it is shown longer.

The new center *O* is set back of, as well as above, the lathe center. The bosses on *F* were so laid out as to bring the edge of a 20-in. disk in the same relative position as that occupied by the front edge of a 10-in. disk on the old center. Since we had only hand turning to do, we found the tool rest *R* sufficient. The lathe tool post, being so far below the new center, does not lend itself very well to cross-feeding. The lathe was run on the low pulley, the large diameter of the work giving it a sufficiently high peripheral speed. The brass bushing *B* is for the purpose of renewal. A short bearing at this point lessens the tendency of the frame *F* to spring out of line in either direction.

Tools in Western Automobile Repair Shop

By O. D. Carter

Since the automobile has reached general use its repair has become an important item. The garage is being transformed into a machine shop and exclusive automobile-repair shops are showing rapid growth. The full economic value must be realized, and this can only be done by judicious repairs.

Herewith is a description of the methods and equipment of a garage shop the facilities of which are somewhat above the average in this section, the central districts of California. The shop is owned by the Waterman Brothers Co., at Fresno.

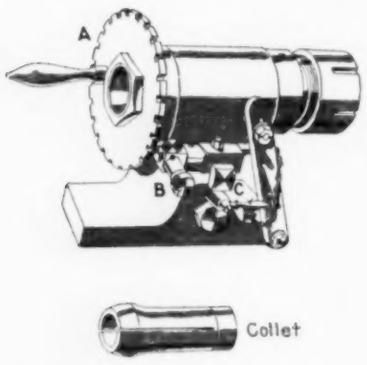


FIG. 1. DIVIDING HEAD FOR GEAR ENDS AND KEYWAYS

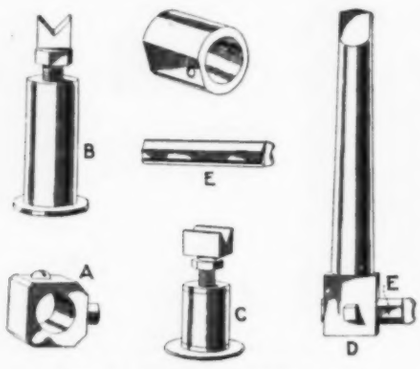


FIG. 2. AXLE DRILLING AND SPLINING TOOL

The machine-tool equipment consists of two Lodge & Shipley lathes of the quick-change type—one 14 in. by 8 ft., the other 20 in. by 10 ft.; a No. 2 Brown & Sharpe miller with dividing head, a Green River universal cutter grinder, two grinder heads, two drill presses and a power hacksaw. A Barnes screw press, a forge and a small oxy-acetylene outfit are also useful. A 4-hp. motor furnishes power.

Slack periods are utilized for making up a stock of axles for the various models of a popular car. These are made of cold-rolled chrome-nickel steel. For squaring the gear end and cutting keyways a dividing head was built as shown in Fig. 1. This has a collet chuck, which holds collets of several sizes. At the other end of the spindle is a disk *A*, having 24 divisions and positioned by the stop pin *B*. A pin *C* locates the angles of the axles while cutting keyways. Two cutters on an arbor, with an adjustable spacer between them, complete the square on the gear end in two passes. Fig. 2 shows a jig at *A* for drilling the gear-retaining pin on another type of axle. Pins riding in the keyway hold it in alignment. Two handy jackscrews, made of tubing, with ends pressed in and hardened swivel blocks on top, are shown at *B* and *C*.

For finishing splined shafts after they are roughed with a small cutter, the cutter and holder *D* are used. The cutter is shaped to the contour of the shaft and held stationary in the holder. A few passes of the table by hand make a neat job. The cutter is shown at *E*.

A holding fixture for slitting bushings of various diameters and lengths is shown in Fig. 3. The shank *B* fits the collet of the dividing head, in which it is held while in use; *C* is pressed on the arbor and is bored to hold the washer, which has a tapered face. A spring behind this washer holds it out against the bushing to be slitted, thus centralizing it. The washer *D* is feathered to slide in a groove on the shaft so that the slits in both *D* and *C* will be in line. Any number of washers may be used as at *E* to make adjustments for length, the nut *F* holding the bushing firmly between the disks. A bushing is shown after splitting at *A*. It must be borne in mind that, in order to keep their cost within reason, all fixtures in a small shop must be made to cover as great a range of sizes as possible.

In making wristpins we found it best to use the special chrome-carbon steel, with holes already drawn. This steel is cut off, the ends faced and taper bored and turned to rough size on an arbor with a tapered shoulder and nut. It is then drilled, hardened and drawn for temper. The latter operation gives good results, saves time and is more satisfactory in every way than case-hardening in small lots. It is only necessary to allow from 0.006 in. to 0.008 in. for grinding, as there is little distortion in hardening. The wristpins are ground on the universal grinder, on the same arbor and in the same position on the arbor as in roughing. The arbors are shown at *G* and the pins at *H*, Fig. 3.

Valves are ground in the small chucks shown at *I* and *J*. The universal cutter grinder is set at the proper angle, the valve stem is placed in the chuck and the whole is swung on centers and driven by dogs on the shank of the chuck. With the new tungsten valves, turning is next to impossible.

In making new pistons, the old piston is sawed in half and one-half used as a core box by the foundry, which saves the expense of making an assortment of patterns.

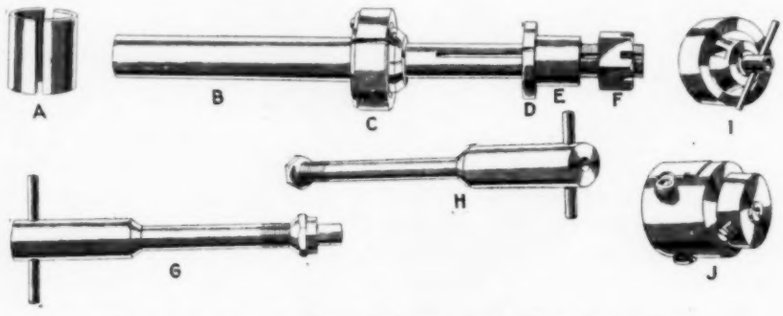


FIG. 3. HOLDING FIXTURE FOR SLITTING BUSHINGS

At *A* and *B* in Fig. 4 are shown a centering device and driving dog for turning pistons of various sizes. The pistons are first held in the four-jaw chuck by the upper end and roughed inside and out, including a cut inside the bosses to insure their being faced central. The pistons are next held in a three-jaw universal chuck and the end roughed, finished and centered. The driver *A* is then screwed on the nose and the piston mounted between the fixture and lathe center. The taper portion will

accommodate pistons from 3 to 7 in. in diameter, and the dog *B* may be any size, as it fits in a slot in the end of *A* and engages the bosses. A cross-boring fixture for pistons is shown at *C*. This is also universal in action, fitting the nose of the lathe spindle. Two beveled strips *D* are bolted to its face, parallel and equidistant from its center. An adjustable stopscrew at the end controls the position of the piston pinhole.

The flexible band *E*, with bolts at each end, fits over the piston and holds it against the strips by means of nuts at the back of the plate.

At *F* are shown a boring bar and a holder. The tools are held by a pin and wedge as shown and are rapid in action. *J* is an adapter for the small lathe. This screws on the nose of the lathe and has the nose of the larger lathe duplicated on its outside, which permits all the chucks and fixtures of the large machine to be used on the small one. This makes the equipment flexible, as the large machine is tied up with cylinder grinding a great part of the time, and at other times the small machine is busy with light work.

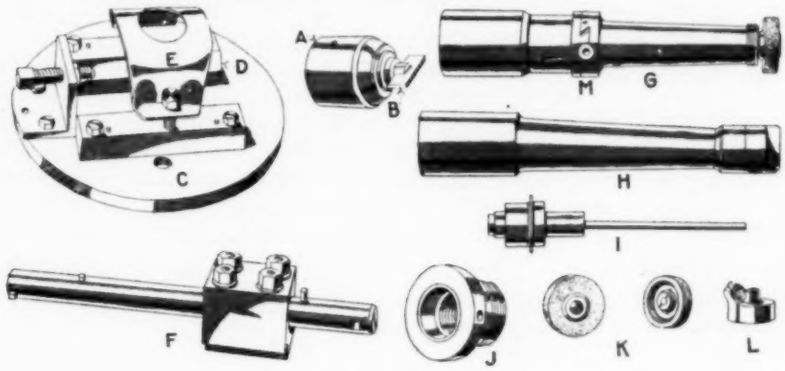


FIG. 4. CENTERING DEVICE AND DRIVING DOG FOR PISTONS

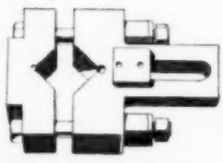


FIG. 7. CRANKSHAFT FIXTURE

FIG. 8. ADJUSTABLE WOODEN GARAGE TRUCK

If too deep to bore and grind out, the scored cylinders are first filled by the oxyacetylene process. Even if filled they will finish at least one-thirty-second larger than their original diameter, due to the falling away of the cylinder while the torch is on it.

A grinder head is shown at *G* and the boring head *H*, as well as the driving pulley and rod for the grinder head *I*. Front and back views of the wheels are shown at *K*. *L* is a boring head for the grinder. The head *L* screws on the grinder supports and carries an inserted tool.

The grinder head screws on the lathe nose as in Fig. 5. It has an eccentric motion, due to an offset, with screw adjustment at *M*. This controls the diameter of the bore when the lathe is in motion. Timken bearings with a spring tension make a free-running bar without chatter. The wheel is driven by the independent belt shown.

The boring head has an offset adjustment at its outer end and is used for removing the filling metal and bringing the cylinders nearly to size, also for chamfering the bore.

A view of the faceplate for holding cylinders is shown at *A*. The faceplate is mounted on the carriage and has screw adjustments both vertically and horizontally. The cylinders are clamped to the back of the plate and supported on the other end with an adjustable bracket, which holds them steady.

For grinding crankshafts, a grinder head, driven from a wooden drum overhead, was made to fit the tool post. This, together with a small internal grinder which may be used in either lathe and driven from the same drum, is shown in Fig. 6. The large head has cast-iron boxes, bored taper, and the spindle is hardened and ground. A hole runs through the spindle, one end forming a split chuck, so that each wheel may be mounted on its own arbor and overhung at will.

Fig. 7 shows a fixture for offsetting the crankshaft while grinding the crank pins. It is adjustable for any size shaft. The center block is adjustable for any throw.

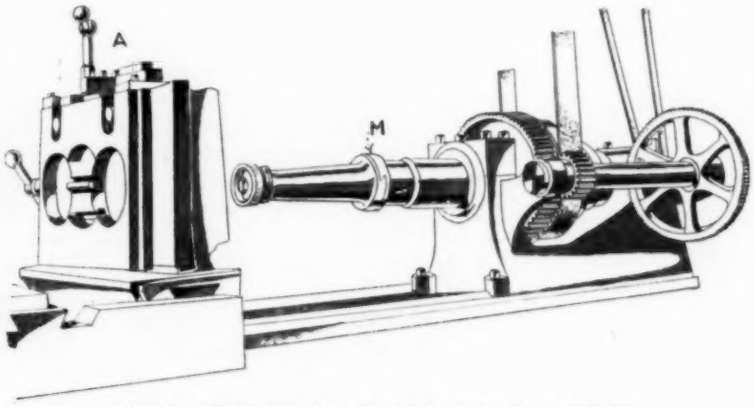


FIG. 5. GRINDER HEAD ATTACHED TO LATHE SPINDLE NOSE

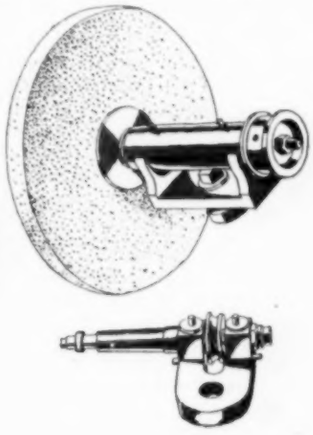


FIG. 6. TOOLPOST GRINDER HEAD

A useful garage tool is the truck or "dolly," shown in Fig. 8. It has an oak beam fitted with rings and a loop at each end. The wheels are bored and run on Hyatt rollers. They are oiled through the hub caps and have oil retainers. An adjustable bar supported by a jack-screw levels the car under which it is placed.

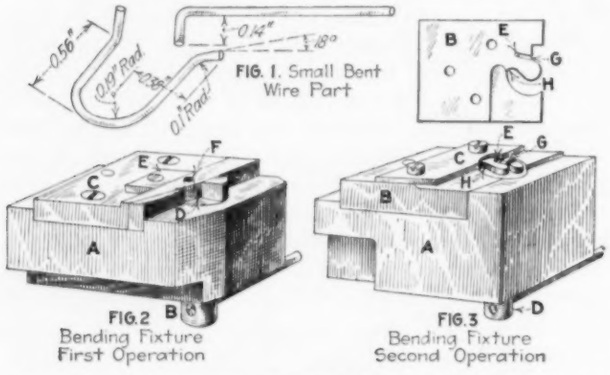
Hand Wire-Bending Fixtures

By G. P. Breitschmid

Short bends in wire can be easily made if proper tools are designed for the operation. A piece that illustrates this is shown in Fig. 1. The specifications call for No. 22 (0.048 in. diameter) music wire. The length before bending is $1\frac{19}{32}$ in.

Two operations were arranged for, to be performed in hand-operated bending fixtures. The first operation makes the short upward bend at one end, and the second the longer circular bend and the reversed end.

The fixture for the first operation is shown in Fig. 2. The base *A* is of cast iron, in which is set the tool-steel wiper *B*, and to which are attached the locating piece *C* and stop *E*. The piece *C* has a hole drilled at *D* to receive the end of the piece of wire to be bent, while *E* determines how far it shall enter. The hole *F* allows the



FIGS. 1, 2 AND 3. HAND-OPERATED WIRE-BENDING TOOLS OF SIMPLE DESIGN

operator to see the end of the wire and make sure it is against the stop. It also lets dirt fall away from the stop.

The method of operating is the same as in other similar fixtures. The end of a piece of wire is inserted into the hole and pushed against the stop. A swing of the handle of the wiper through an arc of a little more than 90 deg. makes the bend.

The fixture for the second bending operation is shown in Fig. 3. It is also made from a cast-iron body *A*, tool-steel locating piece *B* and tool-steel wiper *D*. The shape of *B* is most irregular and must be determined by trial, for the temper of the wire must be taken into consideration and allowance made for the amount of spring back, as in any other bending tool.

The hole *E* and slot *G* in the piece *B* locate the wire by receiving the short bent end in the hole and allowing the long part to lie in the slot. The longer end is guided by the tool-steel piece *C* as it is wiped around the form *B* and allowed to slip between *B* and *C* and receive its final shaping against the surface *H*.

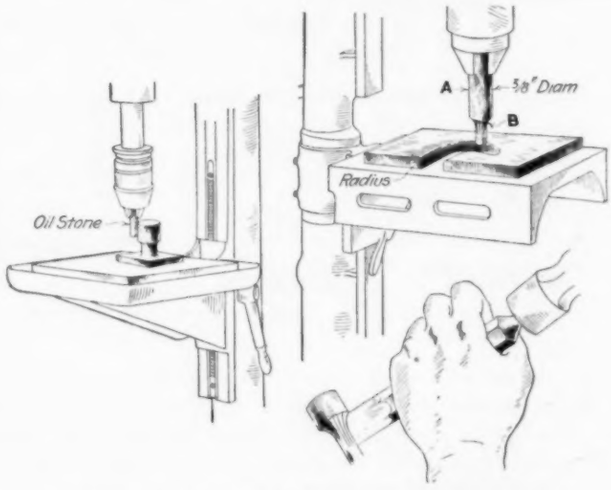
This bend is somewhat difficult and the resourcefulness of the tool maker is called upon to produce it in as simple a way as possible and with the fewest number of bends. The operation of this second fixture is the same as the first.

Each is intended to be held in a vise when in use.

Two Tool-Making Kinks

By Donald Baker

It often happens in fitting punches to dies that in some places the punch fits a little tight. The common practice is to stone off the high spots with an oil stone held in the fingers. A better way, and one that can be used in all places except sharp corners, is to utilize a short piece of round oil stone about ¼ in. in diameter or larger, held in the chuck of the drill press, as shown in



FIGS. 1 AND 2. TWO TOOLMAKER'S KINKS

Fig. 1, and run at a rather high speed. The base of the punch should rest on the drill-press table and should be slid against the revolving oil stone, when the high spots will be quickly reduced.

To do a nice job on stripper plates it is usual to round the exposed edges of the clearance holes through which the blanking punch passes. As these holes are generally irregular in outlin, the edges are as a rule broken by chipping and filing. A better way is to turn up a piece of ⅜-in. drill rod as shown in Fig. 2 at *A*, with a radius and a short teat as shown at *B;* then taking a flat chisel which has had the cutting edge ground on a radius to correspond to the radius at *B*, teeth can be cut as shown in the same manner as cutting a file. After hardening, this tool can be used in a drill press, laying the work on the drill table and holding it against the cutter by hand.

The Iron for Malleable Castings is almost always melted in the air furnace or small openhearth furnace, as it has been found that the cupola cannot be depended upon to give metal of sufficient uniformity to insure successful malleableizing. The composition of the metal has to be kept within quite close limits, which vary in accordance with the size of the castings being made, and the manufacturer has to exercise much skill and ingenuity in designing his patterns and molds. The castings are packed in iron boxes, which are heated to a red heat in annealing furnaces of the ordinary type. They are annealed for several days, and test bars or castings in each box are tested in order to be sure that the process has been properly performed.

Design and Construction of Textile-Machinery Cams*

By Sumner B. Sargent

SYNOPSIS—The detailed steps in calculating and laying out a precision cam, such as is used in actuating the traverse motion of bobbin winders. The method shows how to accelerate the motion at the toe, speed the follow side, retard the stroke side and design several cams in a series from one set of calculations and drawings.

This article takes up the design of two cams representing a class that requires precision and where any error resulting in an unintentional irregularity in the cam's periphery will result in an error in the movement of the cam lever that will be multiplied, in effect, by the number of strokes the cam makes in a given period. One such class is bobbin-building cams on a textile spinning frame. A traverse device controlled by the cam travels from one end of the bobbin to the other end, distributing the yarn in a succession of even layers. In this device, through simple mechanism—usually a ratchet pawl and ratchet gear automatically actuating a screw feed—the stroke of the traversing device is gradually shortened, thus shortening the length of each succeeding layer of yarn on the bobbin. Usually this shortening of the traverse-motion stroke is uniform in length on each end of the bobbin, with a corresponding shortening in length of each succeeding yarn layer.

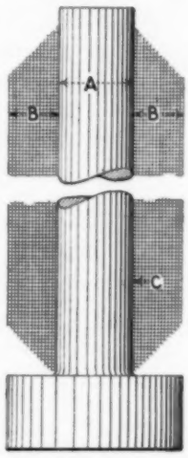


FIG. 1. SECTION OF BOBBIN AND WOUND YARN

This uniform shortening gives a tappered effect at each end of the bobbin. The complete bobbin is in appearance like Fig. 1. Here *A* represents the bobbin and the cross-hatched portions *BB* successive layers of yarn wound on evenly through the medium of a cam, cam lever and automatically shortening traverse device. This sketch indicates the degree of accuracy required for such a cam. Any error at *C* in winding on the first layer is repeated in the same spot in each succeeding layer; therefore the error is multiplied in effect by the number of the layers.

I have twice had occasion to design such cams, and designing them according to the principles that I have outlined have obtained what is called a "perfect cam." In the two shops where this result was obtained the custom had been to design the cams in the ordinary way and then, through repeated trials in operation, filing after each, finally "whip" the cam into acceptable shape.

It is sometimes required in this class of cams that the traverse motion shall move in one direction at a relatively fast speed and in the other at a relatively slow speed, in order better to bind the yarn on the bobbin. Owing to the fact that the yarn is delivered to the traverse motion at a uniform speed and the traverse motion moves at a different speed in each direction, the result will be that while the traverse motion is delivering 100 spirals of yarn wound on the bobbin in one direction of its stroke, it may in the succeeding layer of yarn have delivered only 60 spirals wound on the bobbin. The effect is to bind or tie the yarn on the bobbin. This result is accomplished by having the stroke side of the cam complete its movement in a different period of time from that allotted to the follow side of the cam.

This point is a convenient one to consider the problem of conserving power as much as possible in cam operation.

Generally the stroke side of a cam uses more power than the follow side, and unless the cam is required to reverse, it is usually possible to save power by designing so that the stroke side is given the longer period of time in which to complete its operation. The cam considered in this article will be designed accordingly. It is supposed to have no dwell at either heel or toe, but to give a continuous movement in one direction or the other. While this is supposed to be the movement, there actually is a short period of dwell or inertia at both toe and heel when motion is reversing from one direction to the other. Therefore the cam must be "speeded up" at these two points and remain uniform in movement throughout the remainder of its stroke.

Let us assume that the cam has a stroke of 6 in. To demonstrate the possibility of uniformity in design let us also make a second cam of 5-in. stroke in both cases. The cam lever is to measure 12 in. from fulcrum to center of cam roll in both cases, and the cam roll is to be 1 in. in diameter. To conserve power let us determine that the stroke side of the cam is to operate in 200 deg. and the follow side in 160 deg.

In this class of cams there is another difficulty to overcome—there is always a certain length of yarn between the "bite" of the traversing device guiding the

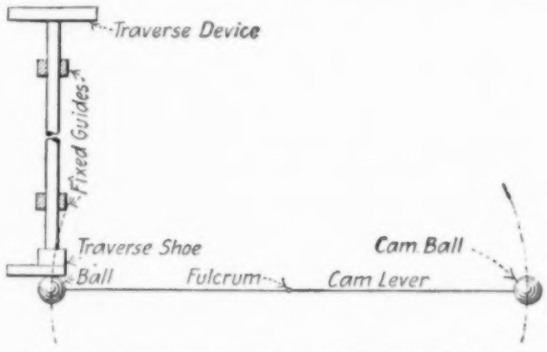


FIG. 2. DIAGRAM OF TRAVERSE DEVICE FOR BOBBIN WINDER

yarn on to the bobbin and the periphery of the wound bobbin. Consequently at the reversing points of the stroke there is a short period during which the traverse fails to guide the yarn positively either in an up or down direction, thus having a tendency to allow the yarn to pile at these points. This is another reason why the movement of the cam should be accelerated at these points. In these

*Copyright, 1916, Hill Publishing Co.

cams the amount of power used increases as the stroke moves toward the toe; therefore to accelerate when approaching the toe point more power will be consumed. I consider that it is better to accelerate the movement after passing the toe point, which brings it on the follow side. For the same reason it is better to speed up the heel of the cam on the follow side and not on the stroke side.

Laying Out the Cams in Detail

The traverse motion moves in a vertical direction in fixed guides, Fig. 2; and as a certain known timing of the movement in this straight-line direction is wanted, the graduations for our stroke can be laid off on a similar

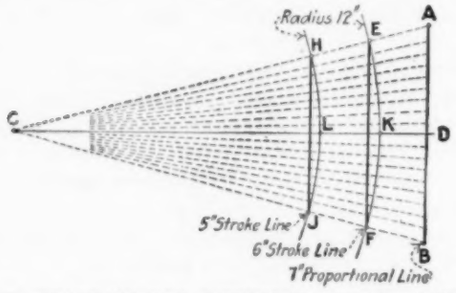


FIG. 3. DIAGRAM FOR DIVISIONS OF CAM LAYOUT

straight line and transferred to the arc representing our cam-lever movement. To accelerate the cam movement at the reversing points I consider it good practice that the first and last graduations on the follow side shall be 33⅓ per cent. longer than the intermediate graduations. It is also wise to use the proportional method of plotting the stroke, whereby all cams in this class may have the desirable uniformity of design to which I have previously alluded.[1] It is convenient to graduate the stroke into 18 divisions. As the first and last divisions of the follow side are to scale one-third longer than the intermediate spaces, it facilitates laying out to select a unit of scale measurement for the intermediate divisions that will be easily divisible by 3—say $\frac{3}{16}$ or ⅜ or ¾, etc.

If we use $\frac{3}{16}$ as the unit we will have for the proportional stroke line 18 (divisions) × $\frac{3}{16}$ in. + $\frac{1}{16}$ (33⅓ per cent. of $\frac{3}{16}$ in.) + $\frac{1}{16}$ in. (33⅓ per cent. of $\frac{3}{16}$ in.) or 18 × $\frac{3}{16}$ + $\frac{1}{16}$ + $\frac{1}{16}$ = 3½ in., the length of our proportional stroke line. This length line will answer, but I prefer to use a line longer than the actual cam stroke, for if one can work within 0.001 in. of accuracy this inaccuracy is less important on a 7-in. proportional stroke than it would be on, say, a 3-in. or 1-in. proportional stroke line. Therefore it is wise to use ⅜ in. as the unit of measure for intermediate spaces. We have 18 × ⅜ + ⅛ + ⅛ = 7 in., the length of the proportional stroke line.

Turning to Fig. 3, erect a 7-in. vertical line, marking off a ½-in. division at each end and ⅜-in. intermediate divisions. Bisect this line at right angles by the line *CD*, which represents the center of the stroke of the cams. From each division point on the 7-in. vertical line extend radial lines to *C*, then erect the 6-in. and 5-in. stroke lines. The radial lines cut the 6-in. and 5-in. stroke lines at points indicating the graduation divisions for those lines.

With a 12-in. radius, representing the 12-in. cam lever, and center on the line *CD*, swing arcs *EKF* and *HLJ*, representing the actual arcs described by the cam-lever roll. The divisions spaced by the radial lines on these arcs indicate the actual spacings for the cams. With a 12-in. radius (cam-lever length) describe the circle *A* of Fig. 4. After determining that the center of the cam strokes shall be 6 in. from the center of the cam hub, with a 6-in. radius swing the circle *B*, representing the center of the cam strokes. The circle *B* corresponds with the points *K* and *L* of Fig. 3.

Turning now to the stroke side of the cam, I consider it good practice to have the divisions of even length; so the 18 divisions are spaced on one of the arc lines in Fig. 4. If these divisions of movement were to be of other than even length—as, for instance, for a uniformly accelerated motion—we would resort to the method described in Fig. 3 to obtain uniformity of movement through the whole series of similar cams. As it is, the 200-deg. segment of circle *A*, Fig. 4, is divided into 18 even divisions and the arcs are swung as in the 160-deg. segment. Then, using the circle *B* to locate the center of the stroke, lay off the 6-in. stroke on one of these arcs, space out the 18 divisions as per Fig. 3 and swing each division mark on to its proper intersecting arc. Then swing the contact circles with the 1-in. cam ball, locating the periphery for the stroke side of the 6-in. cam. In a similar manner lay off the 5-in. cam on Fig. 4 with dotted lines, using the same arc lines and circles *B* to locate the center of stroke. Thus a charted layout like Fig. 3 will

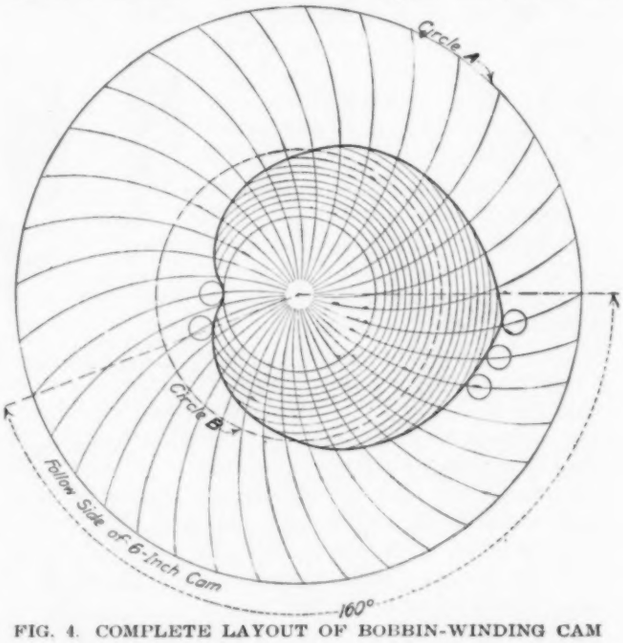


FIG. 4. COMPLETE LAYOUT OF BOBBIN-WINDING CAM

answer for numerous cams of varying lengths of stroke, and one like Fig. 4 will answer in the same way for a number of cams, provided the length of stroke is the only factor changed.

In all dimensions be careful to use a patternmaker's shrink rule and have the patternmaker prick through the tracing to transfer the periphery and center of the cam. All such cams should have cut or stamped in their side an arrow indicating the direction of movement and figures representing the stroke and length of cam lever, thus $\frac{200}{160}$ deg. ← $\frac{6}{12}$. The cam pattern and cam castings then tell their own story, without looking up drawings and details, which are sometimes hard to find.

[1] "American Machinist," Vol. 43, page 376.

Letters from Practical Men

Kink Used in Cutting File Teeth

Briefly speaking, the process of cutting file teeth consists of rapidly driving a chisel into the blank which is laid on a moving table, the table being "geared" for the proper pitch and moved through a nut and lead screw much as is the carriage of a lathe but with this difference —instead of the divided nut of the lathe, a single half-nut is used, which is provided with a handle and lifted out at the end of each cut, the table being returned by hand to the starting position ready for another blank.

For the heavier class of work these tables may weigh as much as 150 lb. They are V-shaped on the under side

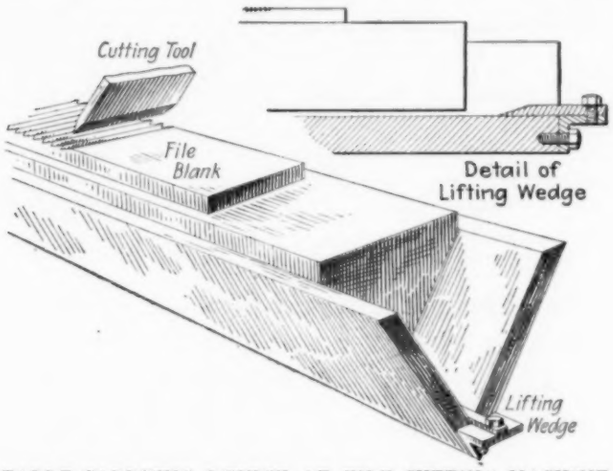


TABLE-CARRYING DEVICE OF FILE-CUTTING MACHINE

and slide in a V-bed just as a planer table runs in its ways. Though ample provision is made for lubrication, the weight of the table, its shape and the hammering it gets from a 100-lb. head at every blow force out the air between the sliding surfaces and unite the table and bed so closely, with the oil as a binder, that any movement of the table by hand must take considerable exertion. In shop parlance the bed is held fast by "suction."

The Madden & Morrison File Co., of Middletown, N. Y., makes great quantities of the largest sizes of files in use and for such the heaviest type of cutting machines is required. The difficulty of moving the beds was overcome by a simple device which is of sufficient general interest to describe, even though its application is a special one.

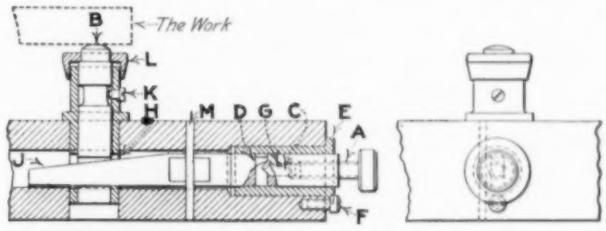
The table is given a fraction of an inch more travel than the length of the file being cut, and a trip is set to disengage the nut from the screw. In the triangular-shaped space, at the bottom of the V-bed and below the table, a wedge-shaped piece is secured near the rear of the machine. The table strikes this piece just as the last tooth of the file is cut and rides up on it during the fraction of travel before the nut is disengaged. This breaks the grip of the bed on the table, and as the latter is pulled back it rides on top of the oil film, which permits easy movement. At the end of each travel the "suction" is broken and the bed freed. The action and the result obtained are somewhat analogous to those in grinding in a valve. The illustration gives an idea of the relation of the parts and the construction. D. A. HAMPSON.

Middletown, N. Y.

Adjustable Wedge Stops for Jigs and Fixtures

Herewith is shown an adjustable wedge stop for jigs and fixtures. It is used mostly on mill and profile fixtures, and is designed to take care of variations of rough castings. The casting is set upon three stationary studs and clamped, care being used that the casting is not sprung in clamping. The adjustable wedge stop is then used by pushing in screw *A* until the contact pin *B* lightly touches the casting, after which the screw *A* is tightened. The screw contacts the pin *C*, which forces the pin *D* against the tool-steel bushing *E*.

The bushing is a snug fit in the body of the fixture and is held in by screw *F*. The pin *G* keeps pin *C* from



AN ADJUSTABLE WEDGE STOP

turning and coming out. The part *H* has a hole drilled and reamed the same diameter as the wedge *J*. The screw *K* prevents the contact pin *B* from coming out. The cover *L* keeps all dust out while allowing full freedom of the parts. The pin *M* holds the wedge *J* in place.

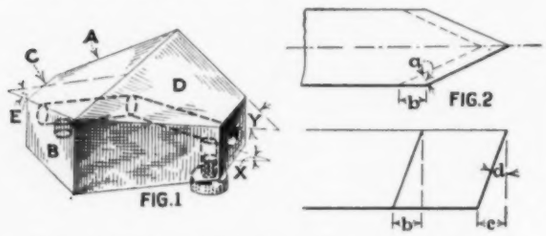
Dayton, Ohio. M. BASSETT.

Grinding Threading Tools

The sketch shows three views of a handy little grinding block, or jig, which I recently made for accurately grinding inserted threading tools on a surface grinding machine. It should prove useful to some of your readers engaged in the production of accurate screw threads, such as taps on screw gages. One end of the block is arranged for 55-deg. angles and the other for 60-deg. angles and can of course be modified to suit any other requirement.

The hole in which the thread tool is placed for grinding is at an angle with the top, to give clearance to the cutting edge. The bottom of the block is machined to the same angle. By setting the faces *A*, *B*, *C* and *D* successively on the magnetic table or chuck, the sides, top and a flat on the point may be ground. For a Whitworth or other rounded thread it is an easy matter to stone the corners off; for a Sellers thread, the correct flat may be ground while the tool is in the jig.

The angle X at which to set the hole to give the desired clearance to the cutting edge, and also the angle Y, may be determined as follows: Referring to Fig. 2, which gives a plan and a side view of the threading



FIGS. 1 AND 2. GRINDING THREADING TOOLS

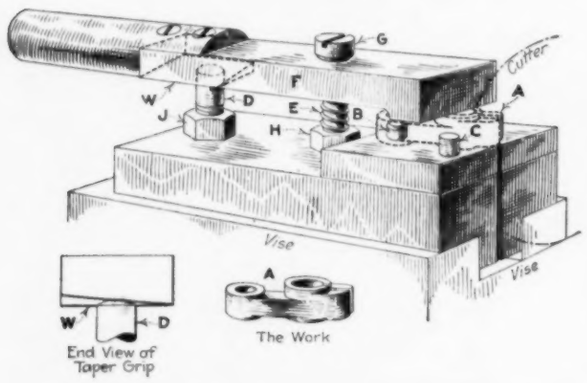
tool, the distance a = tangent of angle of clearance; $b = \dfrac{a}{\sin \frac{1}{2} \text{ thread angle}} = c \times \tan d - c$ = angle of hole in jig with top face.

The angle of the sides of jig may be determined in a like manner for angle E—that is, $\sin E = \dfrac{\sin \frac{1}{2} \text{ thread angle}}{\cos D}$.

London, W., England. J. MAY.

Wedge-Grip Milling Fixture

A vise milling fixture with a wedge arrangement for clamping is shown. The fixture is clamped between the vise jaws of a hand milling machine and is used to mill a clamping slot in work A. The clamp is shown in position as it is when the work is loaded and when it is



WEDGE-GRIP MILLING FIXTURE

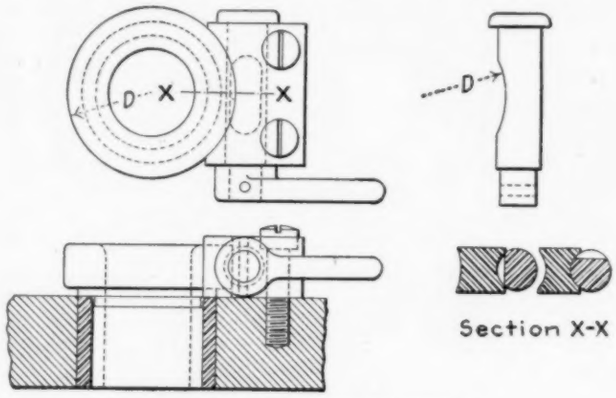
unloaded. After the work is located over pin B and against the pin C the clamp is simply swung over the work until the wedge part W tightens over stud D and over the work. The spring E holds the clamp F in an upright position. The studs D and G can be adjusted to take care of all wear and are locked by locknuts H and J.

Dayton, Ohio. M. BASSETT.

A Lock for Jig Slip Bushings

The illustration shows a rugged lock for small and medium-sized slip bushings. Its only limitation is the size of the bushing, for it will be seen that if the head of the bushing is too great in diameter, the principle of the lock cannot be correctly applied.

In this design the bushing is locked against rotation in both directions and is also secured against climbing up on the drill. This is accomplished by means of a pin which fits into a circular groove in the side of the bushing head when in the locked position as shown at the right in the section XX. This pin is milled out on one side to the same radius as the head of the bushing, so that when the lever to which it is fastened is raised to a vertical position, the relation between the bushing and pin is as shown at the left in the section XX. When the radius cut in the



PIN LOCK FOR SLIP BUSHINGS

pin and the head of the bushing register, the bushing may be withdrawn.

The successful application of this lock is in its use on small-sized bushings and in carefully fitting and hardening its parts. W. BURR BENNETT.

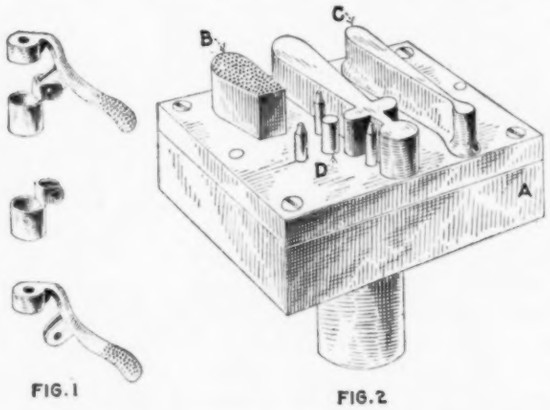
Bridgeport, Conn.

Making a Small Bottle Cap

The bottle cap shown is used in surgical-instrument work. The parts of the cap are shown in Fig. 1 and the dies for making it in the remaining illustrations.

The blanking punch and die are shown in detail in Figs. 2 and 3. The punch holder A carries the serrating punch B, the forming punch C and also the small punch D, which pierces the extra hole into which the stop E fits. This stop is shown on the stripper F in Fig. 3.

This illustration also shows the dies G, which are in two sections—one for blanking, piercing and serrating



FIGS. 1 AND 2. LEVER PARTS AND PUNCH FOR FIRST OPERATION

and the other for forming the lever. They are all set in the bolster H, I being inserted in the die and retained in position by the screw shown underneath it. A section of the bolster is shown at J, together with the screw K,

spring *L* and pad *M*. These keep the tension against the pad *M*, which travels in the blanking die and forces the blank back into the stock.

The section at *O* shows the screw *P*, spring *Q*, the pad *R* and the underpad *S*, which pushes the formed piece back into the strip of stock to be carried along out of the way of the tool. The pins *TT* in the pad *S* are

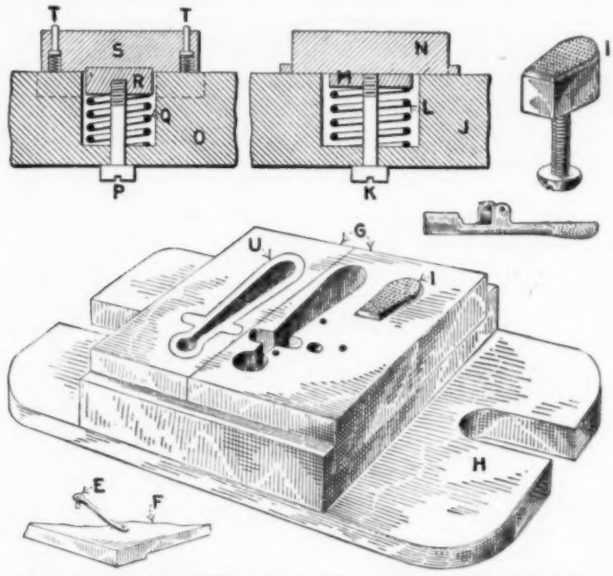
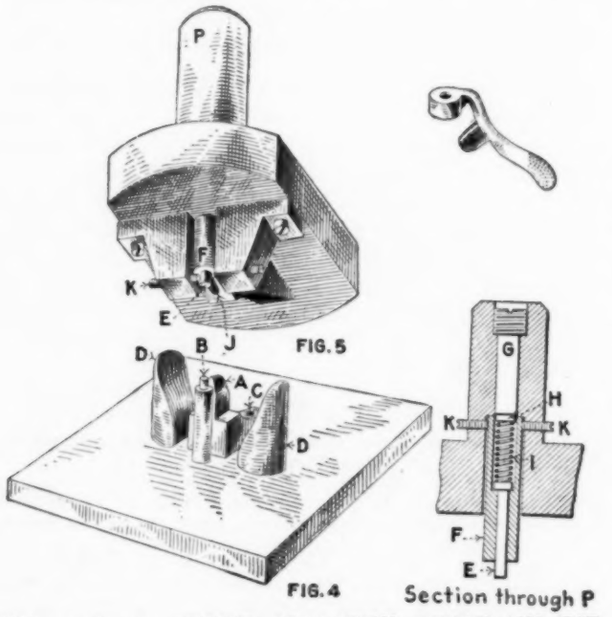


FIG. 3. FIRST OPERATION ON LEVER FOR BOTTLE STOPPER: SERRATE, BLANK, PIERCE AND FORM

shouldered and have springs under them in order to carry the formed piece above the rest, as shown at *U*. The stripper is milled just enough for the stock to pass through in order to prevent any distortion of the material.

Fig. 4 shows the dies used on the second operation, the bending of the lever being done on the shoulder *A*.



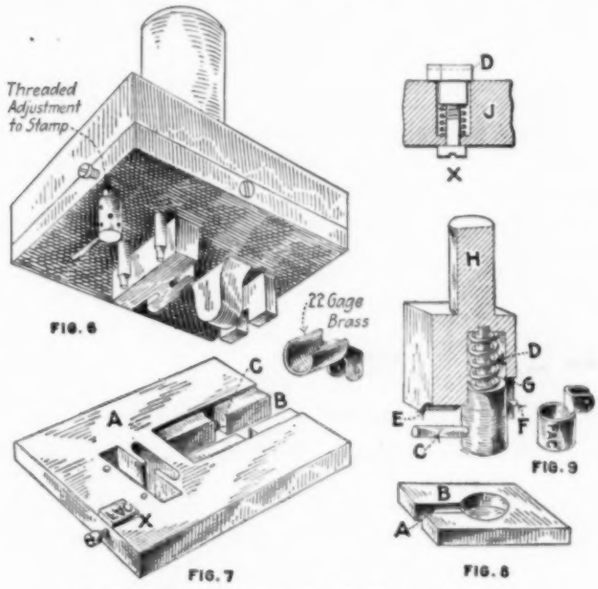
FIGS. 4 AND 5. SECOND OPERATION: PUNCH AND DIE USED IN BENDING THE LEVER

A shouldered stud *B* holds the end of the cap, as indicated by the light outline, while the handle is bent down over the form *C*. The two tapered studs *DD* are equidistant from the center of the stud *B* and are used in forming the ears, the taper forcing in the forming tools on each side of the lever.

In the punch shown in Fig. 5 *E* is a compression pin which travels in the cylinder *F*, the latter being fastened by the two screws shown. The long screw *G* in the shank of the holder presses against the plate *H*, which bears on the spring *I*, directly under the compression pin *E*. This retains the lever in position on the stud *E* during the bending operation.

The bending is not done on a full form, but simply at the shoulder by insert *J*, and the pierced end of the lever enters into cylinder *F* about $\frac{3}{16}$ in. The two pins *KK* engage on the tapered studs *DD*, Fig. 4, and press on the ears of the lever, bending them easily into proper position.

In Fig. 6 is the punch for the first operation on the collar, while Fig. 7 shows the forming die *A*, the blanking, standing and bolster being the same as on the lever and are therefore not illustrated. The die *A* is



FIGS. 6 TO 8. COLLAR PUNCH AND DIES

milled through as at *B*, but beyond the opening for the ears of the collar as at *C* it is milled merely to allow passage of the formed piece, which is carried along with the stock. A section of the bolster is shown at *J* and the pad on which the collar is formed at *D*, with the screw and spring tension beneath. The stripper and stop are built the same as on the lever die.

In Fig. 8 is shown the punch for rounding the stamped part of the collar while the piece is formed by the groove *E*. The sliding movement is governed by the pin *F*, which is in the pin *D* and works in the slot *H*. The results are particularly satisfactory, even though it is a comparatively small piece to handle. In Fig. 1 the pieces are shown full size.

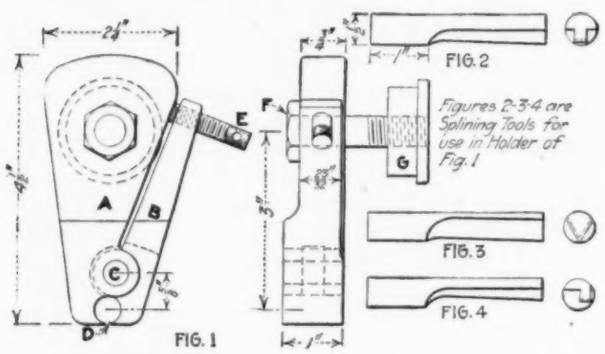
GEORGE F. KUHNE.
Rutherford, N. J.

Shaper Splining-Tool Holder

It is often difficult to spline out dies or similar work in a shaper with the tools at hand. For such work I use a tool holder such as shown in Fig. 1. The parts *A* and *B* are made of machinery steel and are jointed at *C* with a $\frac{3}{8}$-in. pin. The tools are made of $\frac{1}{2}$-in. drill rod, in-

serted in the opening at *D* and securely clamped by tightening the screw *E*, which has a knurled head and a cross-drilled hole. By slightly loosening the screw *E* the tool may be turned to any position.

This holder does away with the tool post, as it is secured to the clapper by the screw *F* and the nut *G*. This allows the use of very short, stiff tools, some of which are shown in Figs. 2, 3 and 4. The one in Fig. 2 is a strong, stiff tool for keyseating. The one in Fig. 3



SPLINING TOOLS AND HOLDER FOR SHAPER

is useful for planing square recesses, for by loosening the screw *E* of Fig. 1 it may be turned to the different positions necessary to work out all four corners.

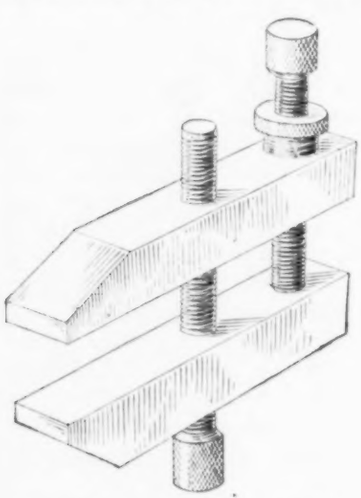
Fig. 4 shows a special form of offset splining tool. I make the tools stiffer by hardening them clear up to the round shank and then drawing to a spring temper, almost to the cutting edge. H. M. DARLING.

Greenfield, Mass.

A Toolmaker's Novel Clamp

The differential clamp shown in the illustration has proved to be quite successful.

The clamp screws of one set that we used had a 17-pitch thread, while the bushing was 16 pitch. The clamp



A TOOLMAKER'S NOVEL CLAMP

is adjusted by means of the screw and then tightened with the screw bushing, thus exerting quite a pressure.

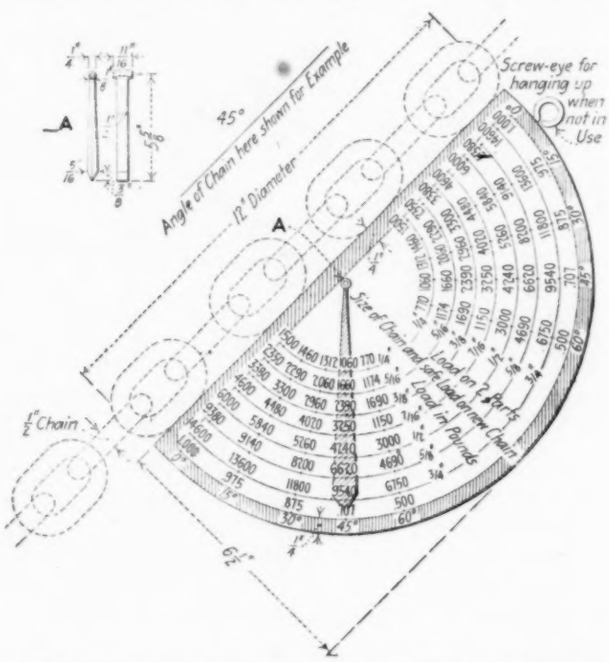
The same idea was successfully applied to some "C" clamps, the fingers being sufficient to tighten the clamps for any job. O. C. KUHRT.

West Haven, Conn.

Gage for Showing Safe Loads on Crane Slings

The illustration shows a gage by the use of which the safe load on a chain- or wire-rope two-part sling may be obtained for any angle of sling from the vertical to 60 deg., by either placing the gage against the sling, as shown, or holding it at a distance at such an angle that its upper edge coincides with the axis of the sling part. It is suitable for all the usual sizes of chain or wire rope, provided they are in good condition.

It is simply a light, seasoned-wood frame *A*, about a foot long (or any other desired size) and three-quarters of an inch thick, cut out on a jig-saw. In the center of



GAGE FOR SHOWING THE SAFE LOADS ON CRANE SLINGS

this frame is freely suspended a small, heavy pendulum. Transparent celluloid is put on each side of the frame, and on this are marked graduations for the safe loads—for chains on one side, for ropes on the other.

The very fact that such an instrument is in the shop and frequently used will lead the men to be more careful, give them a better idea of the effect of the angles on sling chains, and lead them to become better informed on the strength of such things and the weights of the pieces commonly lifted. F. W. SALMON.

Birmingham, Ala.

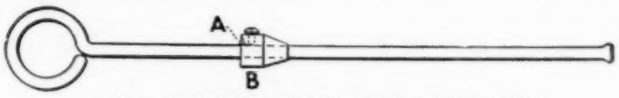
The Choice Between Steel and Malleable-Iron castings is dictated partly by their respective properties, partly by price and partly by the limitations of the processes by which malleable iron is made. As pointed out in a paper read before the International Engineering Congress, steel is, in its nature, a more homogeneous metal and therefore tougher and stronger than malleable iron. Moreover, castings of malleable iron are somewhat prone to actual porosity or sponginess at the center, especially in certain portions of irregular castings, so that for this reason also a steel casting is stronger and more reliable. Finally malleable iron can be made only into castings of quite light sections, whereas there is almost no limit to the size and weight of steel castings that can be produced. For uses where only a fair amount of strength and toughness is necessary, and the castings are therefore of light section, it often pays to buy malleable castings, because they are cheaper than steel.

Discussion of Previous Question

A Core-Venting Wire

The illustration in Vol. 42, p. 376, of a pointed vent wire is incorrect, for strange as it may seem, such a wire should be upset a trifle on the end so that it will push in easily. All skilled molders and core makers know this.

The vent wire with the upset end probably is pushed through more easily than the vent wire with the pointed



A CORE-VENTING WIRE WITH UPSET END

end, because there is less friction of the sand on the wire from the pointed end up.

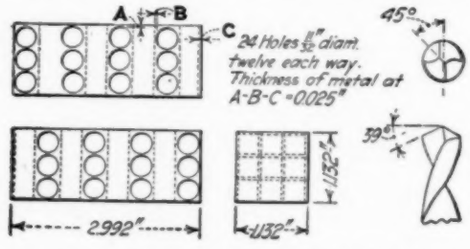
The illustration shows the tip of a vent wire as it should be upset for use. ROBERT E. NEWCOMB.

Holyoke, Mass.

Machinist Instruction in the Public-School System

Mr. Turbon, on page 956, Vol. 43, recommends that commercial machines be built by students. But the question is, What kind of machine could be designed that would require chipping, filing, grinding and scraping of a nature that would be a real benefit to the student?

These operations must be near the danger line of spoiling the machine parts (which may be very costly), or they would be of little or no value as instructional work. We therefore think it best during the early part



EXERCISE IN LAYING OUT HOLES

of the course to give the boy an inexpensive piece of material and make it valuable and important from the standpoint of the student. It is of value to the student because he knows his efficiency is measured and based entirely upon the time it takes to complete the exercise. You may say that this will encourage inferior workmanship, but this is not so if the exercises are properly designed.

For instance, the drilling exercise, shown herewith, is a cast-iron block carefully ground on all sides to dimensions. The student is required to lay off the holes with scale, square and scriber, then to center punch and drill through both ways. The metal remaining between the holes both ways is but 0.025 in. thick. This means that all conditions must be just right or the holes will run together and spoil the block.

There may be various causes for this misfortune, such as inaccurate layout, improper sharpening of the drill, drill not started central with punch marks, block resting on chips, etc. A student can be forewarned about all these troubles; but he looks lightly upon these warnings until he is forcibly convinced by the spoiling of a few blocks that hours are multiplying and that there is more to the apparently insignificant operation of drilling holes than he thought. He now begins to learn, and he settles his mind upon it and after considerable effort he finally succeeds in making a good block. He then finds that repeated failures have taught him the drilling lesson as well as the lesson of paying close attention to the advice given him by the instructor.

I use this example to emphasize the use of carefully prepared exercises for the beginners. I believe that the student can advance more rapidly and fit himself earlier for making actual machine parts by this method than by any other. E. H. KRIEDER.

Lancaster, Penn.

Attitude of Employers Toward Military Training

At the risk of seeming cantankerous, I want to reply again to Mr. Murphy's communication on page 1131, Vol. 43.

Any fear which he has that the employees of an establishment will take advantage of the full-pay-during-encampment privilege just for the sake of the outing would be dissipated if he would familiarize himself with present-day conditions in the National Guard. When employers grant this privilege, it is almost always accompanied—always should be accompanied—by the proviso that the men's proper service be certified by their company captain. This requirement is not at all a hardship on the company captain, and he is desirous of doing it to prevent any imposition on the part of any man, because the captain wants the employer's coöperation. He feels that he should have it; he feels that the militia merits it; and he does not intend that any one of his men shall impose upon his employer, to the detriment of the cordial relations between employer and militiaman.

The duties of the present-day militiaman are so exacting that his enlistment must be actuated by interest and enthusiasm of his own, which far outweigh the inducement of the ten days' pay from his employer. Furthermore he cannot enlist just for an encampment. The pay is a great stimulus, however; and of equally great importance is the interest which the militiaman feels is taken in his militia work by the employer, as shown by this very course—paying the man who is away at the encampment.

Mr. Murphy need not be concerned about the number of men who go to the Plattsburg camp, because those who

attend that camp are required to pay for their subsistence, etc., and as a rule are not drawn from the shop employees, as are the large number of militiamen whom we are discussing.

The militia comes a long way from being what it should be. No one realizes its defects and deficiencies more than the conscientious company commander. To fulfill properly the functions of company commander today requires an inordinate amount of time, which the officers generally take from their families, because they cannot afford to take it from their professional life. They are actuated by the keenest enthusiasm, and there is not the slightest doubt that they would fight with every resource at their command—which happens to be considerable—any attempt of any of their enlisted men to take advantage of the patriotic and public-spirited offer of the employer to give part or full pay during the annual military encampment.

Mr. Murphy is worrying over something which the militia officers do not need at present to worry over—that is, the militiamen from manufacturing concerns being so numerous that their annual leaves will cause financial disadvantage to their employers. If the number only were sufficiently large to cause this embarrassment, we should have a very much better militia, and we should also find some means of preventing the embarrassment. I regret to say that at the present time that is one thing we do not have to worry about. However, it is my impression that after any of our present annual military encampments the participants go back to their work with their working efficiency increased an amount great enough to more than offset the wages the employer has continued during the short absence.

The militia has been damned from hell to hackney, and no doubt has many times deserved it; but a new era has arrived, and we are making the fight of our lives for more cordial relations between the militia and the employer and for mutual understanding, both of which we think we are trying to merit.

PERCY E. BARBOUR,
Second Lieutenant 4th Co., C. A. C., N. G. S. M.
New York, N. Y.

Recording Our Failures as Well as Our Successes

I have read the editorial on page 872, Vol. 43, which impressed me as a timely note of warning and also as good advice. Most of us are extremely interested in reading of other fellows' failures; our own we bury deeply with all speed. Some of us, I fear, find a sort of unholy joy in recording others' failures, often to draw out ridicule, but even in this we may miscalculate the result of our exposures.

The old saw of Prof. John E. Sweet, "The man who never made a mistake is the man who never did anything," recalls a remark I once heard from the late Lord Kelvin, "From my failures have came my greatest successes." But how often do others waste time over these self-same failures through lack of knowledge of what has been tried out long ago! If as you remark, we could start where others have left off, an enormous saving would be effected, which would benefit the human race all around.

A few years ago I was calling upon a prominent engineer and inventor. Just at that time a specialty in competition with his own patented one was being put on the market. A company had been formed and everything looked promising from the outside for a profitable career. Naturally I spoke of this. My friend invited me through his office to his experimental room, and pointing to an object away in the corner, he said: "There's the 'Moon' Co.'s patent. It has been lying there for a good number of years. It was one of my failures."

I did not think very much of it at the time; but had my friend's failure been published, one company at least would not have passed from its birth to immediate death by liquidation. No one can benefit by happenings of this sort. Of course we have the type of man who considers everything he touches to be successful, no matter what others think. In all probability he is hopeless. But if men who have brought out something really successful would place on record the failures they were up against before the goal was reached, we would have some very interesting and instructive reading. Old readers will recall that something of this sort was not the least interesting part of the late Mr. Porter's reminiscences published in the *American Machinist* a few years ago.

One brilliant failure which happened in a shop is worth relating. One day while looking over the stores returns for the quarter, I was alarmed at the number of paint brushes which were being served out to the engineering department, despite the fact that we had a painting department. The method of issuing these brushes was by the foremen's orders signed by themselves, the boy clerks who wrote orders for material not being allowed to write requisitions for brushes. I at once gave directions to the stores that in future all orders for brushes must be accompanied by an old brush; and so long as this was carried out they could accept any signature without question, including the foremen's boy clerks.

It was not very long before I discovered what a lot of paint brushes are really necessary in an engineering department. I was called over by the foreman turner to see a job that had stuck when it shouldn't. It was a large steel valve casting. The man was engaged turning and screwing the body to receive a mild-steel flange already screwed. I found the flange about half an inch from its correct position and firmly "fired" on. I immediately found the cause, and in reply to my question, "Why didn't you put some red lead and oil on the screw, before trying the flange?" I was told, "I hadn't got a brush and I waited nearly half an hour while the laborer went round the shop trying to steal one, but he couldn't manage it."

"Well, why didn't you apply to your foreman, before being such an idiot?"

"He did," said the foreman, who produced an order for one paint brush signed by himself, at the same time informing me that the stores wouldn't accept it, and he was keeping it over to bring before me later on. This little incident was a costly affair, as in the end we had to turn off the flange to save the body.

There were numerous other proofs of my failure. Men were standing idly by while someone fetched a paint-shop boy to put a few dabs of paint inside something before it was closed up for dispatch. Many went out without the paint. But to cut the story short: I visited the stores to investigate and to think out the easiest way of "climbing down." I then found we were using far more brushes than ever, and the stores had the remains of a

previous brush or some part of it for every one issued. These I found were mostly of a pattern quite unknown to our order department. Some ingenious individual had separated one old brush in such a way that it had passed through for two new ones.

Possibly the unkindest cut of all was one foreman's telling me, when talking matters over, that all the boys were becoming humpbacked from going through the streets with their heads down, hoping to find the remains of a paint brush lying in the gutter.

My saving efforts on this occasion were without doubt a dismal failure, but the lesson learned has been worth the money it cost, if only as a guide in my future dealings with supply matters. F. P. TERRY.

Belfast, Ireland.

Best Way To Do Certain Things

In Professor Sweet's article in the *American Machinist,* page 936, Vol. 43, on "The Best Way To Do Certain Things," his first example is "the best way to put a wheel or lever on the end of a shaft, particularly if it is one that has to be removed and replaced, is to put it on a fairly steep taper and fasten it by screwing a nut on the end of the shaft, and if it is something that must occupy a fixed position, a key will serve to locate it."

I don't know of any better way. Capstans are put on that way on turret lathes. On screw machines they are placed on the end of the shaft that runs through the sleeve in the saddle, engaging with the rack in the slide and operating it. But this matter of a fairly steep taper is one that leads to trouble in this instance, at least in my experience. Professor Sweet says "particularly if it is one that has to be removed and replaced." That means it is to go on, stay tight and come off easily, and that this "fairly steep taper" will give such a result.

The first consideration is that the capstans shall go on tight. They do that—I can testify to it—but they do not come off easily. I have frequently had to remove the slide from the saddle and remove the saddle from the machine, place it upon its side and drive the pinion shaft through the capstan. This upsets the thread upon the outer end and causes trouble when replacing the nut. Capstans are very often put on without a key, and the taper used is of so slight an angle that while it does not slip, it often sticks when it is to be removed, and it will not come off without something more than rapping.

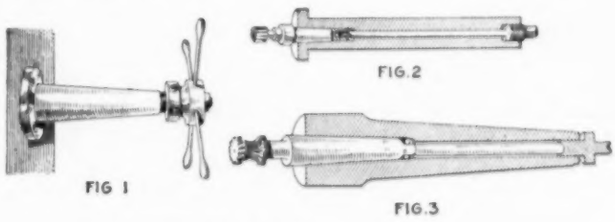
Some years ago I used a Jones & Lamson lathe built before the days of the Hartness flat turret lathe. Upon the end of the carriage feed shaft instead of the usual cone and belt of those days there was a gear. The hole through this gear was of such a taper that it would slip if from any cause an unusual strain was put upon it, as by the belt. The end of the feed shaft had keyed upon its driving end a taper sleeve that fitted the gear. The stretching of the belt in a belt-feed lathe and its consequent slipping on the cone and stopping of the carriage are annoying, as anyone who has operated one of these lathes well knows. This gear connection of the Jones & Lamson people was intended to overcome such trouble, and my experience was that it did.

Somewhere between the taper of the gear on the feed shaft of this lathe, which could always be removed by the hand without rapping, and the taper used in the capstan hub of the screw machine or turret lathe there may be a taper of such an angle that it will not slip when tightened by a nut and will come off easily when the nut is removed. If there is not, a key should be used, as suggested by Professor Sweet.

A key is an additional expense, and the makers of these tools have preferred to use a taper that will not slip, and to let people who have to remove the capstan get it off the best way they can. A nut upon the end of the sleeve which will bear against the inside of the capstan hub will force it off however tight it may stick, without the usual pounding on the hub with a babbitt hammer or the trouble of taking off the slide and saddle, as shown in Fig. 1.

The machine that in my experience has been most abusively treated with the hammer is the profiling machine, and some milling machines have been a close second. The cutters and collets on the profiler and the arbors on the miller are usually driven into the spindles with a babbitt hammer. The tang of the cutter collet, or arbor, reaches to a slot cut through the spindle at a convenient point back of the lower, or front, housing for the insertion of a taper key to drive out the cutters, which frequently stick. In this way they are a source of trouble and cause a loss of time in removing.

Some makers have tried to overcome this difficulty by making the spindles hollow and using a long collar-



METHODS OF HOLDING PARTS

head bolt that reaches through the spindle. In the tang end of the cutter, or arbor, a hole is tapped. Into this hole the bolt screws and draws the cutter to its seat in the taper hole in the spindle. This method is good as far as it goes, but to remove the cutter you must slack the bolt and pound upon its head. Such treatment is bad for the thread in the cutter and on the bolt.

If the rear or upper end of the miller or profiler spindle were counterbored for a short distance and threaded with a pitch somewhat finer than that of the extreme end of the bolt which engages with the cutter tang at the opposite end of the spindle, the bolt could be screwed into the counterbored portion a certain distance and the cutter collet screwed upon its other end, which reaches a short distance into the taper hole at the other end of the spindle. Then by a few turns of the bolt the cutter would be drawn up to its seat in the spindle, and by unscrewing the bolt the cutter would be forced in the opposite direction and easily unscrewed from the bolt and taken out of the spindle. Fig. 2 shows this fastening.

The difference in the pitch of the threads on the two ends of the bolt will cause the cutter to be drawn to its seat in the lower end of the spindle at a more rapid rate than that at which the thread on the head end of the bolt retreats from the threaded counterbore in the upper end of the spindle. It is a differential screw and it has some pull to it.

The cutter can be screwed upon the lower end of the bolt while the bolt is held from turning until the cutter seats itself slightly, or as far as it can be turned with the fingers. Then with a wrench upon the bolt head the cutter can be finally tightened. This method ought to do away with the pounding.

When collets become stuck in spindles so badly that the spindle must be removed from the machine, the best way I have found to get it out is to cut a thread upon the collet head, run on a nut and draw the collet out. With a wrench on the put it can be done in less time and with less injury to the machine than by warming up and expanding the spindle and pounding it out.

The common practice with profiler and milling-machine spindles has been in days past to make the spindles solid. Then after chucking the taper hole for the cutter in the proper end of the spindle, a slot is put across the spindle at such a distance from its end that the tang of the cutter projects into this slot sufficiently so that by inserting a taper key in the slot and driving it in with a hammer the cutter is forced out of the spindle. The tang upon the cutter prevents it from turning around if it fits the slot into which it projects; but from the nature of the work of both machines, and perhaps more particularly the profiler, the cutter depends much more upon the fit in the taper hole in the spindle to keep it in place than it does upon the tang. Consequently the operator drives the cutter into the spindle with such force that in time the taper hole becomes enlarged, or bell-mouthed, as the metal wall surrounding the taper hole from the shape or taper must be thinner at the extreme end of the spindle than farther in. Accordingly it spreads at that point. When the distortion has become so pronounced as to prevent the cutter from holding, the spindle must be rebored or reamed. The bolt will do away with this trouble, which I found to be a very serious one. It means changing gages for the taper after the hole has been enlarged, and the annoyance of having two or three different sizes in the profiler spindles.

The bolt is used by manufacturers of profilers and has been for years. It is an excellent way of holding tools in a taper hole anywhere, but I have never seen a bolt that will remove the cutter as well as draw it in. Some collets are made with removable tangs, and with this form the only office of the tang is to present a surface for the taper key to rest on when driving the collet out of the spindle. Collets are used principally to reduce the cost of cutters by making the cutters with very much smaller shanks. As such cutters are usually small ones, the taper shank without the solid tang is sufficient to hold the cutter. The life of the collet is much longer than that of the cutter, so it is an advantage to have a removable tang in it. Tangs either solid or removable become bruised and broken from rough usage. The collet outlasts several of them. Running entirely through the collet is a hole made as large as possible without weakening the tang end of the collet or cutting away any of the taper hole in the other end.

It is sometimes convenient to remove the cutter without taking out the collet. A piece of tempered drill rod, placed in the hole through the collet, of such a length that it reaches from the end of the cutter to the end of the shank of the tang, raising its collar head slightly from the end of the collet, will do this. When the taper key is inserted in the spindle slot and driven in, it forces the tang shank against this piece of drill rod and against the cutter tang, driving it out of the collet and leaving the collet in the spindle. The collet shanks are ground, the tang end being scraped to fit a 60-deg. center. This enables the cutter to be sharpened while it is in the collet, causing it to run true. Fig. 3 shows a collet with a removable tang and cutter.

Springfield, Mass. J. P. POLAND.

Oxyacetylene Welding in 1913 and 1915

After reading the editorial on page 784, Vol. 43, I am prompted to add a few remarks on this important subject, for I am strongly in concord with your comments on the treatise referred to.

It is true, undoubtedly, that oxyacetylene welding methods have gone far beyond repair work. In fact it is a question if the process is used as extensively at the present time for repair work as in the manufacturing industries of the world. Personally I am decidedly of the opinion that if statistics could be obtained it would be found that the process is used far more extensively in the manufacturing industries than in repairing. The process has no limitations as to classes of metal—aluminum, brass, copper, iron and steel are welded with equal facility. The oxyacetylene method when employed on manufacturing parts is not only quick, but enables the operator to weld where it would be difficult or impossible to work by any other method. There are the further advantages of neatness and strength over the antiquated methods of soldering, brazing and riveting. It now affords one of the most powerful, valuable and economical methods of dealing with an immense variety of manufacturing operations, which can be carried out without any injurious effects upon the metal.

It is impossible to enumerate in anything like complete detail all of the various kinds of work now being executed in the metal-working industries, but the following will no doubt suffice to show that the flame-welding process is not confined to repair work. It is used at the present time in the construction of metal railway vehicles, automobiles, aëroplanes, bicycles, metal motor boats, petrol tanks for submarines, for torpedo boats, for motor vehicles and aircraft, boilers, retorts, evaporating pans, safes, cylinders, machine protection guards, castings impossible or difficult to mold by making in parts and uniting, pipe manifolds and connections of intricate forms, metal doors and furniture, casement frames, artistic metal work, sanitary and domestic articles, etc. A. EYLES.

Manchester, England.

Electric or Blow-Pipe Welding of blow-holes and shrinkholes in steel castings is now a practice recognized in specifications. If the defect is not so located as manifestly to make the casting unfit for use, and if the defect is properly repaired, a welded casting is perfectly satisfactory. The defect, however, should be really eliminated, not simply plugged—as was pointed out in a symposium on iron and steel, presented before the International Engineering Congress. By opening a hole to the bottom with the flame or arc, much as a dentist prepares a cavity in a tooth for filling, and then filling it with metal that is welded to the partly fused walls of the hole, the casting can be made truly sound. The hardening effect of the high temperature and rapid cooling upon the steel adjacent to the weld, especially in medium and hard castings, and the stresses set up by the cooling of large welds make it essential in a great many cases that the casting be reannealed after welding.

Editorials

Another British Restriction

The hint that Great Britain, by royal proclamation, might restrict the importation of other things than machine tools was well founded. Dealing in optical instruments is now to be controlled. A cablegram from the American consul-general at London, dated Dec. 20, reads:

"Minister of Munitions prohibits all dealings without license in certain optical instruments, including prismatic binoculars, monoculars, telescopes, periscopes, and compasses for reading and azimuth angle simultaneously with sighting of object."

It is understood that this does not prevent legitimate, established importing. The firms carrying on such business, however, must obtain a license and subject themselves to Government regulations. The purpose in issuing the proclamation is to put in the hands of the Minister of Munitions complete control of certain things that are needed in the production of war materials.

Perspective Illustrations in "American Machinist"

In a narrow sense the illustrations in the pages of technical journals serve the same purpose as the headlines in newspapers. Both attract attention. Both give individuality. Both are features intended to appeal to busy readers by the power to give information in a compact form. It is but natural therefore to find from year to year an increasing number of illustrations appearing in the pages of technical journals.

From a broader viewpoint the illustrations on the page intended to convey technical information serve a more important purpose than merely to attract attention and give individuality. The reproduced drawing, sketch or photograph is a means of conveying ideas, and is therefore a form of language. It is a form of expression that can be used widely in technical journalism and has tremendous possibilities for worth-while results. By no other means can information be presented in so compact a form, and from no other form of expression can ideas and facts be grasped so quickly by the reader. If anyone wishes to prove this statement to his personal satisfaction, let him write a description of the geometric shape of an egg so that he will completely and unmistakably describe the object to a man who has never seen one, and then set the result of his efforts alongside a rough pencil sketch of an ordinary hen's egg. The mess of words will promptly go into the waste basket or kitchen stove.

As the language of engineering and shop drawing has numerous kinds and modes of expression, a heavy responsibility is put upon the technical editor to select the one best adapted to convey the information that is to be presented to his readers. In the machinery-building field the perspective form has a number of advantages. By comparison, orthographic projections are puzzling—especially when reduced to a small scale for the purpose of reproduction—and halftones are apt to be obscure, due to the loss of sharpness in detail from engraving, and from the additional fact that photographs taken in dark machine shops are not apt to possess the clearness necessary for successful reproduction.

For these general reasons the *American Machinist* has continued to use more and more perspective drawings and sketches during the last two years. During 1915 a new form of perspective known as the "background perspective," was adopted to show jigs, fixtures, punches and dies, die-casting molds and other small tools. The success of this form prompted further experiment, which has resulted in another form of perspective, known as the "flat-tone perspective." Examples of this new type appear for the first time on pages 14, 24 and 25 of this issue.

Both of the processes have been developed by A. L. Ormay, chief draftsman of the Hill Publishing Co. They will be used freely in the *American Machinist* throughout the year 1916, particularly for presenting details, with the expectation that the essential points of jig, fixture, small-tool and machine-part design will be presented in a clearer, more compact fashion than is possible by any other method.

Great Britain's Trade in 1915

The European war has clearly been the only factor of any importance in the economic position of the United Kingdom during the year that has just passed. An observer would have noticed apparently a remarkably prosperous condition of internal trading. As regards overseas trade, when imports and all exports are added together it will probably be found that the total is £100,000,000 (say $500,000,000) or more in excess of the total for 1914. But prices have risen, and the increase in the figures is in fact due to the imports. Export total values are down. At the moment of writing, it is somewhat difficult to make an estimate, but exports of British production should reach £385,000,000, plus exports of foreign and colonial produce of about £100,000,000, or a slight increase on 1914. Unless a marked drop shows in the last week or so of the year, imports should reach £850,000,000, far in advance even of 1913.

Great Britain always has had on the surface a trade balance in the wrong direction. There are, however, the well-recognized invisible exports, important among which is the shipping industry. Although an unknown but extremely large proportion of the total number of British ships are employed on Government service, the increase in freight rates has been so high that the shipping gains will probably exhibit an increase. Of the three sides on which the influence of Great Britain in the European war is most important, namely, naval and military, financial, and external trade, it is perhaps the financial that is causing the most thought. Expenditure is growing and for war purposes has now reached probably £5,000,000 a day. The income for the same purpose is about one-

quarter of this. Clearly the national debt increases. Great Britain in many ways is carrying on the war regardless of expense. In rate of expenditure she is easily ahead of all the other countries concerned, taken individually. but about one-third of the expenditure is in loans to British dominions and allies and therefore cannot be regarded as a dead loss.

According to the latest estimates the yearly income of the United Kingdom is about £2,500,000,000, while that of Germany is not very different, though the relative populations, say 68,000,000 of Germany against 46,000-000 of the United Kingdom, must be remembered. An effect of the war, however, has been to consolidate the British Empire, and here the total income for the past year has been estimated at something like £4,035,000,000. India is counted at £700,000,000, Canada at £350,000,000, Australia at £230,000,000, Crown Colonies, etc., at £150,-000,000, New Zealand at £55,000,000, and South Africa at £50,000,000. Up to a certain point, at any rate, Great Britain is paying for the war, and her figures as to overseas trade and treasury payments and receipts are available from month to month.

In Great Britain the adverse trade balance has decreased month by month, and in various ways, including some revision of the fiscal policy, attempts are being made to equalize the values of exports and imports. Considering the facts that the German, Austrian and other markets are not available, and that even before the recent army increase some 10,000,000 workers had been withdrawn from useful production, the figures available relating to overseas trading must be regarded as hopeful. Though it is the Englishman's privilege to grumble, there is no real pessimism as to the future.

Of course the cost of living and prices generally have advanced, and costs of production have risen ever since the outbreak of war. Some 4,500,000 workpeople, it has been estimated, have had their wages raised by something approaching a total of £40,000,000 a year. In many instances increased earnings are not being used with a view to the future; nevertheless savings have increased to about £600,000,000 a year. A remarkable feature of the British, and in fact of the whole European, situation is the extraordinary influence of the state as a stabilizer of conditions. In Great Britain the state has assumed complete control of the railways, Government insurance has been effected of commerce and even of property (against Zeppelin raids), the banks have been supported by the use of public credit, prices of various commodities have been regulated, foreign trade has necessarily been controlled, and in many respects in the engineering world an industrial revolution has been effected. Up to the beginning of December some 2,026 engineering establishments were directly controlled by the Government, a department deciding what work should be done and in what order. This has applied with particular force to the machine-tool industry, all the shops being engaged to the fullest capacity, while many firms that never dealt with machine tools save in the way of usage have been kept going as fast as possible on their production.

Machine-tool exports have fallen considerably both as regards quantity and total value, although values per ton have naturally risen. Total export values will probably not reach £800,000. Imports, even at the end of last November, almost touched the £2,000,000 mark, a value five times that of the same period of 1914.

It is beyond question that the present engineering output could not have been attained without the large increase in the employment of women on machining operations. Whole factories are being run solely by female labor, as regards machine work, and the initial conservatism which is inherent in almost all British people having been overcome, nothing but praise is heard as a rule for the efforts of the women, who seem happy at their work, partly perhaps because of the additional opportunities for social intercourse. In machine-tool work more particularly they have made a start, but not much more. Female employment in this branch is steadily growing, however, the women as a rule being given comparatively simple repetition work on the smaller machines, often leaving work requiring more skill for the men who take their places in the evening. No single type of machine tool can be recalled that is not being operated on these lines by British women.

In Great Britain the output of machine tools for home consumption is enormous, and in this respect at least the war has some advantageous features for the British engineering industry. Shops are being equipped with modern tools which in many cases are simplified to meet the present purpose only, but the construction leaves the addition of further parts in the future easily possible. A lathe intended, for instance, for what is known in England as "sliding" will not be fitted with a lead screw for screw-cutting purposes until later. In addition the machine-tool industry itself is revising its outlook, and firms that made many types of tools are contenting themselves, sometimes under Government direction, with one or two types, on which they have advantageously introduced more modern methods of manufacture. Thus the British machine-tool industry will probably at the end of the war be in a condition to give a good account of itself when the rebuilding and reëquipment of Belgium, northern France, parts of Russia and so on, must be undertaken.

Why Exact Comparisons Are Often Difficult

There are many fundamental truths which are hard to prove because we have no exact comparisons, nor can we have in many cases except by laboratory methods. We all know that a rigid building that prevents or absorbs vibration must give better results with cutting tools than one that allows the machines to weave, or change location on the floor. True, some machines have weight enough and are stiff enough to do good work even in a shaky building, but they are the exception.

Direct comparisons of this, however, are few and far between. For when we move from the old wooden shop to the new one of steel or concrete, or a combination of the two, we never arrange machinery in just the same way and usually speed up the line shaft or change the methods in other ways. And every change, no matter how slight, makes exact comparisons out of the question.

Every testing engineer knows that the only way to secure reliable results is to change one thing and only one thing at a time. In no other way can exact data be secured.

This condition explains why we are lacking in exact comparison in many shop matters, things which it often seems that we should know all about.

Shop Equipment News

Mechanical Planer Controller

Electric drive of a planer by means of a reversing motor is the most severe machine-tool drive of present-day practice. Not only is a very special motor necessary, but the control of this motor with regard to speed and accuracy of reversal is very exacting. This difficulty has been solved in various ways in the past by the use of contractors and electrically controlled switches, and current relays. The Cutler-Hammer Co., however, has made a mechanical problem of this control, and a 48-in. by 14-ft. Cincinnati planer equipped with its apparatus has been in successful use for several months in the shop of the Triumph Electric Co., Cincinnati, Ohio. Among the many advantages of the mechanically operated controller an important one is that being a mechanical device it is in a class of machinery easily understood by the planer operator and therefore likely to receive proper attention from him.

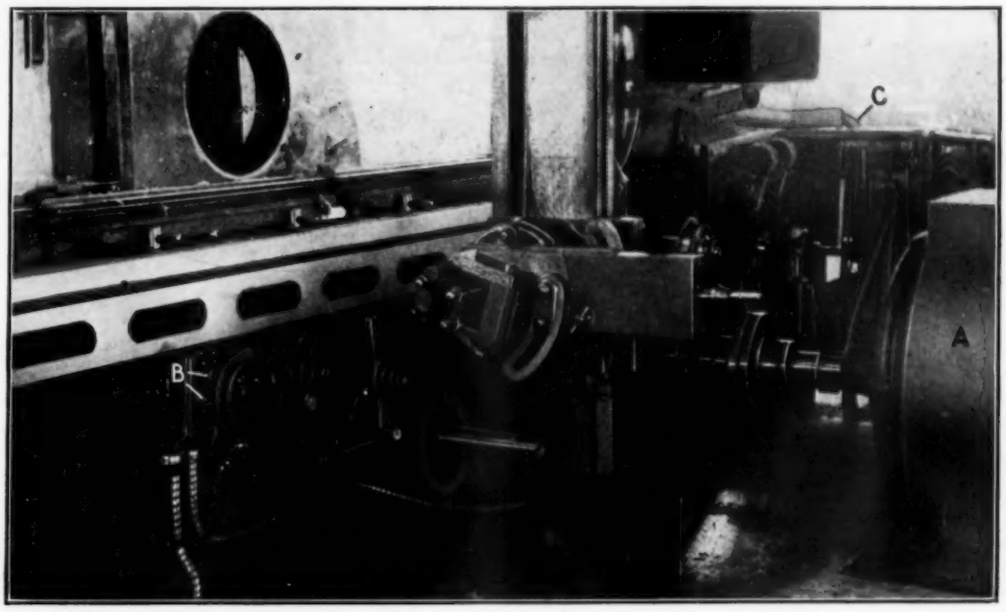


FIG. 1. GENERAL VIEW OF PLANER CONTROLLER APPARATUS

The setting and general arrangement of the apparatus are shown in Fig. 1. Here the motor is shown at *A* and the two push buttons for starting and stopping, at *B*. The main part of the controller is contained in a rugged cast-iron box *C*, with doors on each side to protect the contents. In the pictures the doors are shown open. The box, or casing, is also shown in front and rear views in Figs. 2 and 3 respectively. This controller is intended for use with an adjustable-speed compound interpole motor, and it is arranged to cut out the compound field after the motor has come up to speed, and also to give separate adjustment to the cutting and return speeds. The controller box, or casing, contains two shafts, the first of which is called the "reversing shaft" and the second the "accelerating shaft."

The reversing shaft is operated from the ordinary reverse gear and dogs of the planer through levers, shown at *D* Fig. 3, and it moves a short distance from the center in either direction. As this shaft rocks back and forth, a set of cams on it alternately close the motor circuits, thereby causing the motor to rotate in one or the other direction. Simultaneously the accelerating shaft is released so it is free to rotate through a certain angle, the speed of rotation being controlled by an air dashpot, shown at *E*, Fig. 2. As this accelerating shaft slowly turns, it moves another series of cams which close switches that short-circuit the armature resistance and the series field, and at last insert the shunt field resistance so as to bring the motor up to maximum speed.

In reversing the motor from one direction to the other, the shunt field is first strengthened so as to produce a dynamic braking action of the motor. The motor acts as a generator and feeds power back into the line. Then resistance is all inserted in the motor circuit, and when it has reached a sufficiently low speed, the armature circuit is reversed and the motor accelerated in the opposite direction. By proper setting of the various cams and proper adjustment of the dashpot, the reversing time can be adjusted in such a manner that the current surges on the motor are always kept down near the normal full-load current of the motor, even when reversing from high-speed-forward to the higher-speed-reverse. The commutation of the motor is at all times sparkless.

As mentioned above, the shunt field resistance of the motor permits independent adjustment for cutting and reversing stroke. This is accomplished by means of two field regulators which are mounted in the cover of the casing, as shown at *F*, Fig. 2. When conditions make it

advisable, these regulators may be mounted separately. Mounted as shown, however, they are easily accessible to the operator. The starting resistance is mounted in a separate frame, and in individual cases may be placed on top of the controller case, on the planer housing, or wherever most convenient.

In addition to the apparatus described above, there is a single-pole, double-throw solenoid switch. When energized, this solenoid switch completes the line circuit to the motor, and the planer may be operated. When the switch is deënergized, it completes a dynamic brake circuit of the motor and produces a quick stop. This is for the purpose of bringing the motor to rest quickly in case the line current should fail, or if the operator should wish to stop for any reason. Ordinarily the operator stops the motor by pulling the tumbler, which forms part of the regular planer reverse, to central position. The reversing shaft of the controller will return to the "off" position and disconnect the motor from the line. On the other hand, if very quick stopping with dynamic action is required, the operator pushes the stopping button in the two-button station mounted on the planer bed, and previously referred to at *B*, Fig. 1. This opens the solenoid circuit of the above-mentioned clapper-switch, thereby closing a dynamic circuit and bringing the motor to the desired quick stop. If the operator again desires to start the motor, he brings the tumbler of the operating mechanism to center, or "off" position, and pushes the other control button. This last action closes the solenoid switch connecting the controller to the power circuit, and it is then only necessary to throw the tumbler in the forward, or reverse, direction, to start up the machine.

On test, the equipment has shown that the minimum stroke at which the planer will operate is only limited by the setting of the table dogs, and by the use of properly designed dogs the cutting distance can be reduced to any required amount. The only attention this apparatus requires is the occasional filling of the grease cups which lubricate the bearing surfaces. As the controller is amply supplied with these cups, no other lubrication is required, and weekly or fortnightly inspection will keep the mechanism in perfect condition.

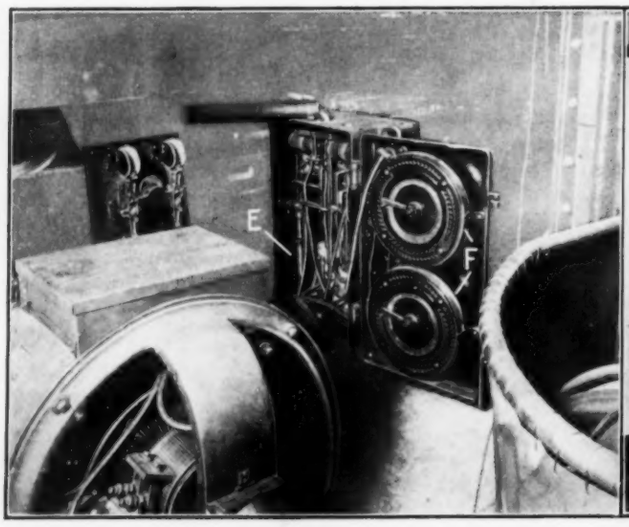


FIG. 2. FRONT VIEW OF MAIN MECHANICAL PLANER CONTROLLER BOX

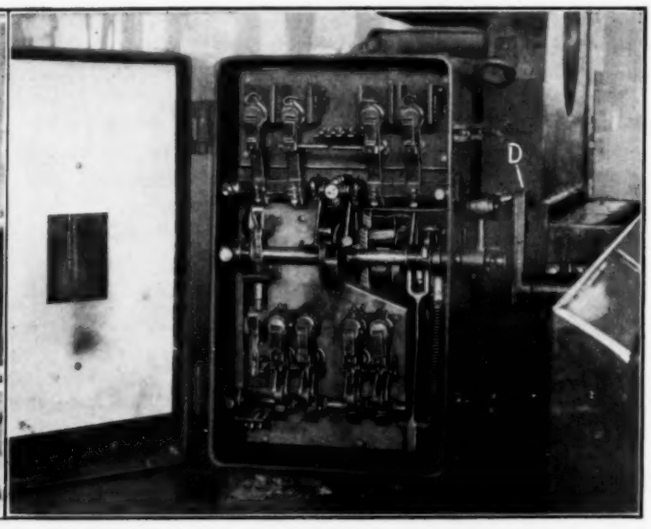


FIG. 3. REAR VIEW SHOWING SHAFTS AND LEVER CONNECTIONS FOR THE CONTROLLER

All-Metal Lift Trucks

The type of lift truck shown resembles closely the four-wheeled one described on page 38, Vol. 43. Several improvements, however, have been added. The lifting hook is made to release automatically, so as to permit the free use of the handle. The hydraulic check mechanism is so made that the platform may be easily lowered when empty, without the usual necessity of standing on it or using a weight. The front wheels can be turned completely around with the platform in either elevated or lowered position. On account of the lever or handle being free, the truck can be easily guided under the wooden platforms at will.

The truck is of all-steel frame construction, and the bar-steel cross connections render the making of trucks of any width an easy matter. The wheels are equipped with roller bearings and are regularly furnished 6, 7 or 9 in. in diameter on any of the trucks, as ordered. These trucks weigh from 215 to 295 lb. net, and up. They are made by the Stuebing Truck Co., Cincinnati, Ohio.

IMPROVED ALL-METAL LIFT TRUCK

Heavy Manufacturing Lathe

The Hindman high-duty lathe shown, recently placed on the market by the Duff Manufacturing Co., of Pittsburgh, Penn., was designed especially to meet the demand for a low-swing lathe of extreme power, for turning diameters which are too small to put in larger lathes. The machine was designed to be capable of turning any diameter, from the smallest up to 12 in. at approximately the proper cutting speed.

The drive is by tight and loose pulleys with single belt from the main line; or a two-speed countershaft can be used, giving two changes of speeds with one change of gears. The loose pulley is mounted on roller bearings. The bed is so arranged that the motor can be bolted to it, and it can be arranged for either a gear drive or a silent chain drive. The arrangement of the pulley also permits the motor to be bolted to the floor. The main driving gear on the spindle is 18 in. in diameter with $3\frac{11}{16}$-in. face, and it is made from a forged and rolled section. The pinion meshing into this gear is cut from a solid bar, carbonized, heat-treated and ground.

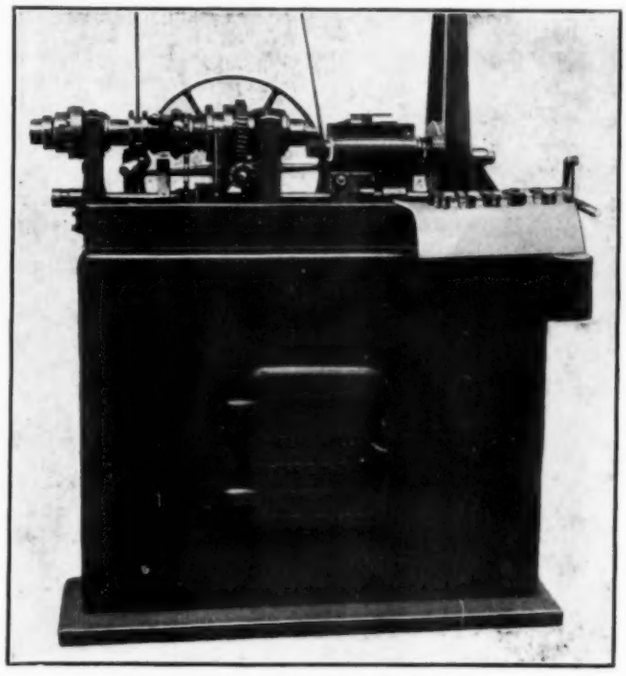
There are three changes of speeds furnished by means of slip gears—all of steel. The pinions of these change gears are all carbonized, heat-treated and ground. The smallest pinion of the set is made of vanadium steel. The speed changes are in the following ratios: 11 to 1, 14¼ to 1, and 18¼ to 1. The feeds regularly furnished are five, ranging from 0.020 to 0.100 in. in steps of 0.020 in. each. These changes are obtained by means of slip gears similar to the speed changes. All of the feed gears and change gears are of steel of ample proportions to stand heavy duty.

The apron is of the double-support type, and is equipped with reversing mechanism. All gears are constantly in mesh. The carriage is made heavy with wide ways and large bridge. The tool rest is made of a steel casting. The bed is of the box-type pattern, heavily reinforced and is so arranged that it can be easily equipped with a turret. The weight of the machine, with 8-ft. bed, is about 5,000 lb.

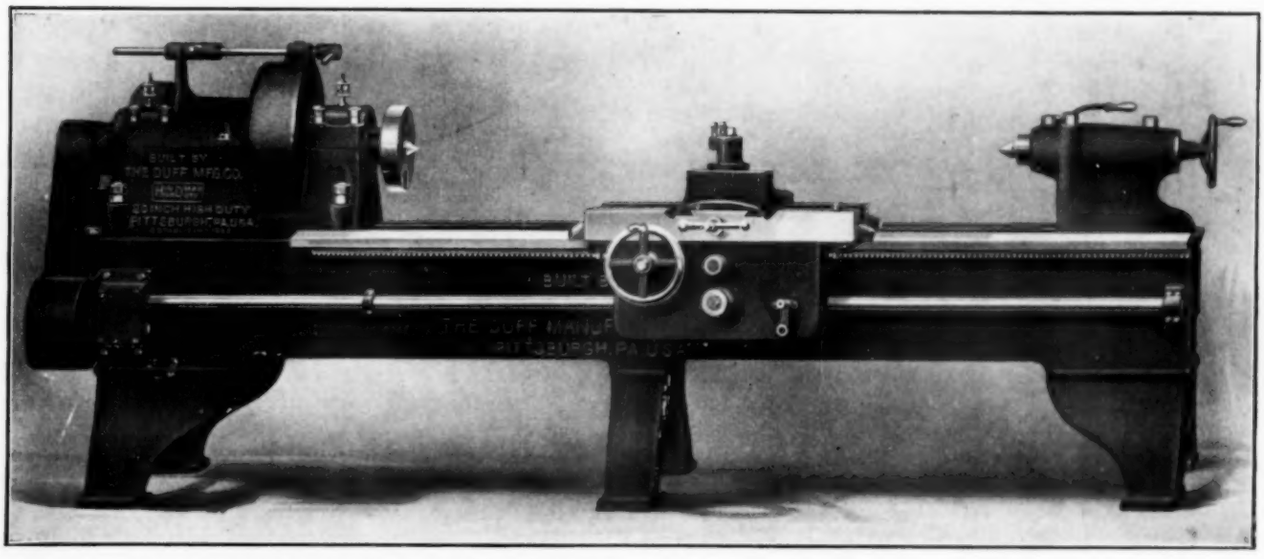
Semiautomatic Thread Miller

The thread miller shown was designed especially for threading bronze primer bodies. The piece is held in a lever-operated spring chuck and advanced into position by a hand-operated cam, the work spindle being rotated by a worm and wormwheel acting through a jaw clutch. After the piece is chucked, the hand lever raises the cutter into the worm and starts the work spindle. On completion of the thread the cutter is withdrawn, and the work spindle automatically returns to its original position.

There is a graduated adjustment for depth of thread for use in setting the machine. The cutting time is 20



SEMIAUTOMATIC THREAD MILLER
Overall dimensions, 48x12 in.



HEAVY-DUTY MANUFACTURING LATHE ESPECIALLY ADAPTED FOR TURNING SHELLS
Swing over ways, 20 in.; over carriage, 12 in.; distance between centers, 8-ft. bed, 40 in.; width of bed over ways, 20 in.; front spindle bearing, 5x7 in.; width of belt, 4½ in.; length of carriage, 30 in.

sec., which gives an average of over 100 per hour. The machine shown handles work up to 3 in. in diameter, and a larger one is also built on the same general lines to take work up to 10 in. in diameter and 30 in. long. It is made by the T. C. M. Manufacturing Co., Harrison, N. J.

Portable Shop Crane

The superstructure of the portable crane shown is made of steel in order to secure lightness. The base is of cast iron, with its braces, ribs and lugs cast integral and made sufficiently heavy to provide the necessary strength. The light superstructure and heavy base give the crane a low center of gravity.

The caster and the two front wheels support the base at three points so that twisting strains in passing over uneven floors are eliminated. Steering is accomplished by the caster in connection with the all-steel handle. The

PORTABLE SHOP CRANE
Capacity, 1 ton; lift, 6 ft. 6 in.; overhang, 33 in.

crane is locked by the hand nut, shown on the caster, which can be operated by the foot without stooping.

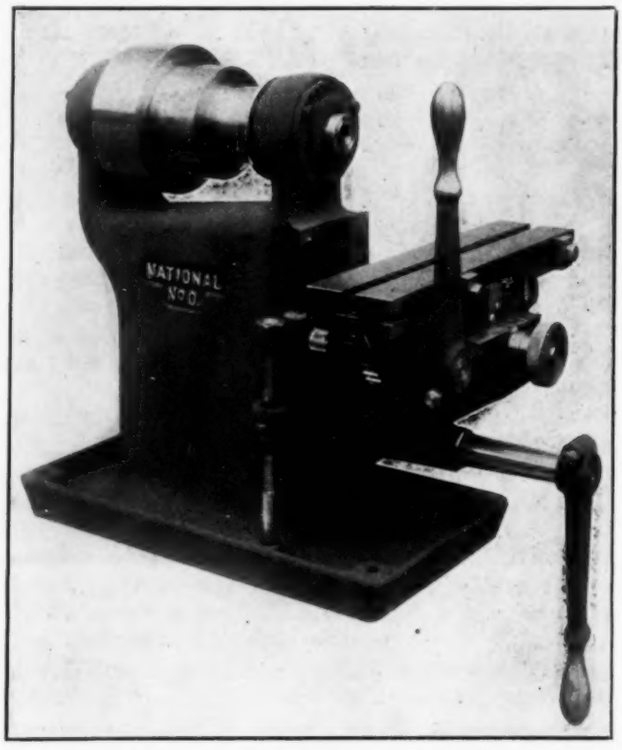
On the one-ton size shown, a single chain is used which automatically runs to the sheave pulley at the top and is out of the way of work under the crane. A bridge on the sheave-pulley casting prevents the hook from running off. The hook is drop forged of heat-treated steel with a large factor of safety. The chain winds on the drum singly.

This crane is made in several sizes by the United Engine and Manufacturing Co., Hanover, Penn.

Column or Bench Hand Miller

The machine shown is intended to be used either as a column mounted or a bench hand miller. It was designed to meet the demand for a small miller adapted for splining or milling small parts at high speed. Parts of rifles, revolvers, automatic machines, typewriters, sewing machines and the like can be machined with great rapidity.

The spindle is made of high-carbon steel, ground all over and mounted in ball bearings which are provided with dust-proof covers. All sliding bearings are unusually wide and provided with gibs which can be adjusted



COLUMN OR BENCH TYPE HAND MILLER
Working surface of table, 3⅜x13 in.; longitudinal feed of table, 6½ in.; vertical adjustment of knee, 5 in.

for wear. The crossfeed knob is graduated to read in thousandths. Both table and knee are provided with adjustable stops. The machine is provided with spindle speeds of 100 to 1,200 r.p.m. The height of the bench machine without column is 18 in., weight 175 lb.

The machine is a recent product of the Bickett Machine and Manufacturing Co., Cincinnati, Ohio.

Copper Band-Turning Machine

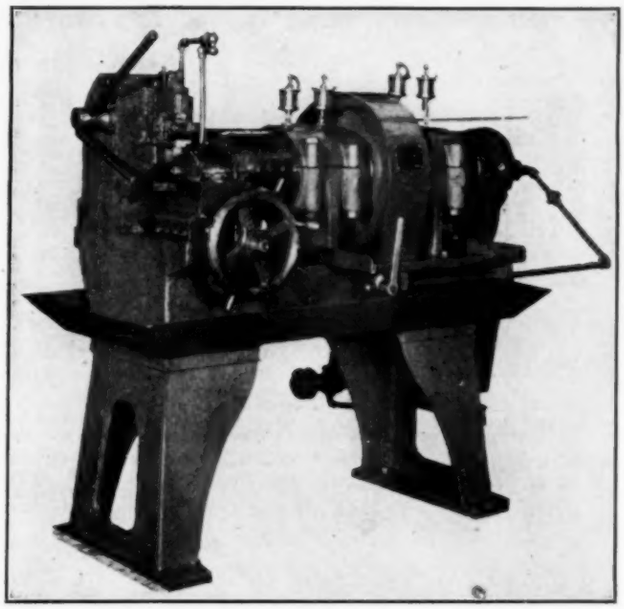
For the forming of copper driving bands on high-explosive and shrapnel shells, the Traylor Engineering and Manufacturing Co., Allentown, Penn., has developed the machine shown.

The positive opening and closing chuck, operated by compressed air, is used for holding the work. A valve and lever placed in front of the machine make it easily controlled. The chuck is positive and allows ready replacement of a shell in the machine. The forming of the copper band is done by two tools easily operated.

The machine is arranged for taking any shells, from 2 in. diameter up to and including 6 in. diameter. The operation of the machine is such that a roughing cut is first taken off, which brings the band down to size. The mechanism for taking this cut is so designed that it is not necessary to work to figures. Consequently high-class skill is not required. The finishing cut is operated by a lever on the back of the machine, and no gaging of any

kind is required to bring the band down to the proper diameter and form.

In the turning of the copper driving bands on 18-pounder high-explosive shells, the rate of production has been as high as two shells per 50 sec. This includes all of the necessary time required to take the shell off the



COPPER BAND-TURNING MACHINE

rack or floor, put it in the machine, turn up the band, remove the shell from the machine and put another one in its place. A fair average for this machine is 100 shells per hour, making it possible to turn out 1,000 shells per machine per 10 hours.

Friction Clutches and Pulleys

The aim in designing this clutch has been to avoid unnecessary weight, secure easy operation and maximum adjustment for wear, with simplicity of construction.

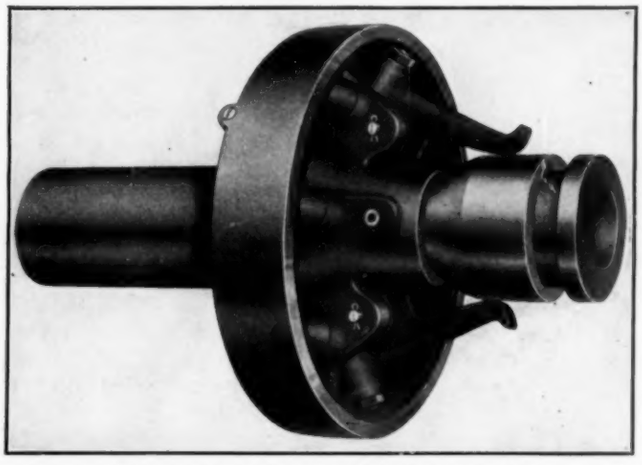


FIG. 1. EXPANDING FRICTION CLUTCH

Clutch sizes, 9 to 12½ in.; diameter, 1 7/16 to 2 7/16 in. shaft. Pulleys, 8 to 16 in. diameter, 3 to 6 in. face

The body is keyed to the shaft and held in position by a hollow setscrew. It carries two friction shoes which work on the inner surface of the rim of the hub, as

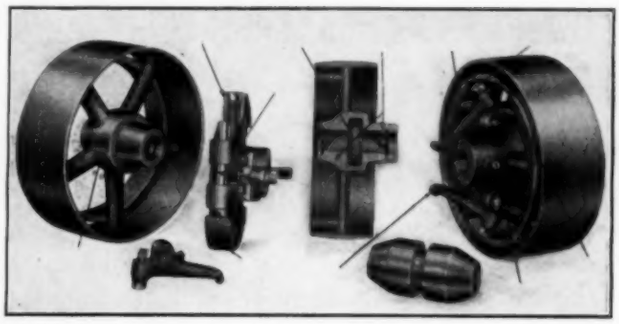


FIG. 2. PARTS OF FRICTION CLUTCH

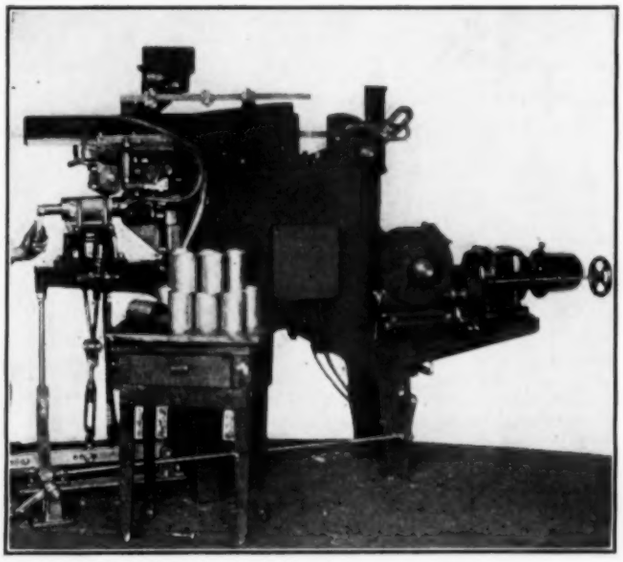
shown. These shoes are expanded by wedges in the ends of the arms, these wedges being easily adjustable. Springs hold the shoes away from the pulley when not in action and prevent any tendency to drag. Ample lubrication is provided by means of an internal reservoir.

Clutches range from 4 to 12 hp. at 100 r.p.m. They are made both as separate clutches and in complete countershafts by the Bicknell-Thomas Co., Greenfield, Mass.

Electric Seam Welder

The illustration shows a motor-driven electric seam-welding machine recently developed by the Toledo Electric Welder Co., Cincinnati, Ohio.

The machine is designed for rapidly welding cylinders made of sheet metal or lead-coated stock. The welded



ELECTRIC SEAM WELDER

surface is left smooth, permitting enameling or other finishing without any further preparation.

PERSONALS

Albert Vuilleumier, until recently assistant chief engineer of the Becker Milling Machine Co., has become works manager of the Standard Machinery Co., Mystic, Conn.

Thomas F. Fournier, chief engineer of the Becker Milling Machine Co., Hyde Park, Mass., has resigned to become general manager of the Standard Machinery Co., Mystic, Conn.

W. P. Cartwright has been placed in charge of the die room of the Buick Motor Car Co., Flint, Mich. Mr. Cartwright was formerly associated with the Anderson Forge and Machine Co.

Prices--Materials and Supplies

PIG IRON—Quotations were current as follows at the points and dates indicated:

	Dec. 30 1915	Dec. 3 1915	Jan. 2 1915
No. 2 Southern Foundry, Birmingham	$14.50	$14.00	$ 9.50
No. 2 X Northern Foundry, New York	19.50	17.75	14.25
No. 2 Northern Foundry, Chicago	18.50	18.00	13.00
Bessemer, Pittsburgh	20.45	18.95	14.70
Basic Pittsburgh	18.95	17.45	13.45
No. 2X, Philadelphia	19.50	17.75	14.25
No. 2, Valley furnace	18.50	16.00	13.00
No. 2 Southern, Cincinnati	17.40	16.40	12.40
Basic Eastern Penn	18.50	17.50	13.50
Gray forge, Pittsburgh	18.20	16.45	13.45

METALS—Below are the present quotations with a comparison of practically a month and year ago:

MISCELLANEOUS METALS—NEW YORK

	Dec. 30, 1915	Dec. 3, 1915	Jan 2, 1914
	Cents per pound		
Copper, electrolytic (carload lots)	22.50	20.00	13.25
Tin	40.00	38.00	33.25
Lead	5.40	5.25	3.80
Spelter	18.00	17.50	5.85
Copper sheets, base	27.00	25.00	18.50
Copper wire (carload lots)	30.25	28.25	13.25
Brass rods, base	32.00	27.25	13.00
Brass pipe, base	36.00	32.00	15.50
Brass sheets	32.00	27.25	13.25
Solder ½ and ½ (case lots)	24.75	23.50	21.00

In St. Louis lead sells at 5.32½c. per lb. and spelter at 17.75c.

MONEL METAL—The following prices hold:

Size, In.	Mill Lengths 8 Ft. and Over: 10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less than 500 Lb. of a Size and Over
Rounds—Squares	Cents per Pound				
⅛ — ⅜	31.50	32.00	32.50	33.00	36.00
½ — ⅝	31.25	31.75	32.25	32.75	35.75
¾ to 1¼	31.00	31.50	32.00	32.50	35.50
1⅜ to 2½	31.75	32.25	32.75	33.25	36.25
Rounds 3 to 3⅛	32.50	33.00	33.50	36.00	37.00
Squares 3	32.50	33.00	33.50	36.00	37.00
Rounds 3¼ to 3½	32.25	32.75	33.25	35.75	36.75
Squares 3⅛ to 3½	32.25	32.75	33.25	35.75	36.75
Rounds—Squares 4 to 4½	33.00	33.50	36.00	36.50	37.50
5 to 6½	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ¼ in. thick.
Hexagon Bars two cents (2c) per pound over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

STANDARD PIPE—On carload lots f.o.b. Pittsburgh the following discounts hold:

	Black	Galvanized
¾ to 2-in. steel, butt welded	78%	63½%
2½ to 6-in. steel lap welded	77%	62½%
7 to 12-in. steel lap welded	75%	58½%

At this rate prices are as follows:

Diameter	Cents Black	Cents Galvanized	Diameter	Cents Black	Cents Galvanized
¾-in.	2.53	4.19	5-in.	34.04	55.50
1-in.	3.74	6.30	6-in.	44.16	72.00
1¼-in.	5.06	8.39	7-in.	59.50	98.77
1½-in.	6.05	10.02	8-in.	62.50	$1.03
2-in.	8.15	12.55	9-in.	86.25	1.43
2½-in.	13.45	21.92	10-in.	$1.03	1.70
3-in.	17.59	28.68	11-in.	1.16	1.92
4-in.	25.07	40.87	12-in.	1.27	2.10

NAILS—Wire nails f.o.b. Pittsburgh sell at $2.10; galvanized 1 in. and longer, $4.10, and shorter, $4.60. These prices are to regular customers and delivery is made at the mill's convenience.

ROLL SULPHUR in 360-lb. bbl. sells in New York at $2.15 per 100 lb.

STEEL SHEETS FROM JOBBERS' WAREHOUSE, NEW YORK

	Dec. 30, 1915	Dec. 3, 1915	Jan. 2, 1914
	Cents per pound		
No. 28 Black	3.15	3.15	2.60
No. 26 Black	3.05	3.05	2.50
Nos. 22 and 24 Black	3.00	3.00	2.45
Nos. 18 and 20 Black	2.95	2.95	2.40
No. 16 Black	2.90	2.90	2.35
No. 14 Black	2.80	2.80	2.25
No. 12 Black	2.70	2.70	2.20
No. 28 Galvanized	5.50	5.25	3.50
No. 26 Galvanized	5.20	4.95	3.20
No. 24 Galvanized	5.05	4.80	3.05

ZINC SHEETS—The following prices prevail:

Quantity	Cents per Lb.
Carload lots, f.o.b. mill	22.00
In casks, New York	23.00
Broken lots, New York	24.00

SEAMLESS DRAWN TUBING—The base price is 33c. for brass and 33c. for copper. For immediate stock shipment 3c. is added, which gives the following quotations in cents per lb.:

Diam., In.	Brass	Copper	Diam., In.	Brass	Copper
¾ to 3	36.00	36.00	5	42.50	42.00
3½	37.50	37.00	6	43.50	43.00
4	38.50	38.00	7	45.50	45.00
4½	40.50	40.00	8	47.60	47.10

OLD METALS—The following are the dealers' purchasing prices in New York:

Copper	Cents per Lb.	Brass	Cents per Lb.
Heavy and crucible	17.75	Heavy	11.50
Heavy and wire	17.25	Light	9.50
Light and bottoms	15.00	No. 1 yellow rod turnings	14.00
Lead		No. 1 red turnings	11.50
Heavy	4.50		
Tea	4.25	Zinc	11.00

COKE—Below are the prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Dec. 11 1915	Dec. 18 1915	Dec. 25 1915	Jan. 1 1916
Prompt furnace	$2.15@2.25	$2.50@3.00	$3.00@3.50	$3.00@3.50
Prompt foundry	2.90@3.25	3.25@3.75	3.50@4.00	3.50@4.00

STEEL SHAPES FROM JOBBERS' WAREHOUSE, NEW YORK

	Dec. 30, 1915	Dec. 3, 1915	Jan. 2, 1914
	Cents per pound		
Steel angles base	2.40	2.40	1.85
Steel T's base	2.45	2.45	1.90
Machinery steel (bessemer)	2.40	2.35	1.80

The above prices are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger.

WELDING MATERIAL (SWEDISH)—Prices are as follows:

Welding Wire	Cents per Lb.	Cast-Iron Welding Rods	Cents per Lb.
3/32, 1/16, 5/64, 1/8, 5/32, 3/16	8.50	¼ by 19 in. long	22.00
No. 8, 5/32 and No. 10	9.25	5/16 by 12 in. long	26.00
1/8	10.00	3/8 by 19 in. long	20.00
No. 12	11.00	½ by 21 in. long	20.00
5/32, No. 14 and 1/16	12.00		
No. 18	14.00	Vanadium Wire in Coils or Sticks	
No. 20	16.00		
Special Welding Steel		1/16	15.50
		5/64	15.00
1/8	33.00	3/32	14.00
5/32	30.00	1/8	12.00
3/16	28.00	5/32 and larger	11.00

The above prices are subject to change according to quantity and shipment desired.

BAR IRON—Prices are as follows at the places named:

	Cents per Lb.
Pittsburgh, mill	1.80@1.85
New York	2.00@2.07
From storehouse, New York	2.40@2.50

SAL SODA—The quotations below are per 100 lb. at the places designated:

New York	$1.00
Philadelphia	.75

Manufacturing British 18-Pounder High-Explosive Shells--II*

By E. A. Suverkrop

SYNOPSIS—The processes through which the shell blanks have passed have, strictly speaking, been roughing operations in which merely sufficient care has been exercised to prevent the loss of work and material, but there has been no attempt to secure great accuracy. From now on a greater and increasingly greater degree of accuracy and care becomes necessary as the work advances toward completion, final inspection and acceptance.

Up to the first operation in this article the base of the shell blank is, with the exception of the center, in exactly the same condition as it was when it left the cutting-off machine. As previously stated, the bulk of the blanks are cut on cold-sawing machines, and as the exterior of the bar stock is not true the base is consequently not square with the now rough-turned body of the blank. The base must therefore be faced off square with the body, so that later operations can be satisfactorily carried out.

For the sixth operation short, heavy engine lathes are used. It may be mentioned that on all these operations the machine and chucks used are considerably heavier than is really necessary to handle the work, the object being to have ample rigidity and pulling power. The lathes are of 20-in. swing with 6-ft. bed and no tailstock. They are equipped with heavy combination chucks, as shown in Fig. 15. The roughing tool is mounted in the tool post. The operator just cleans up the base and does not

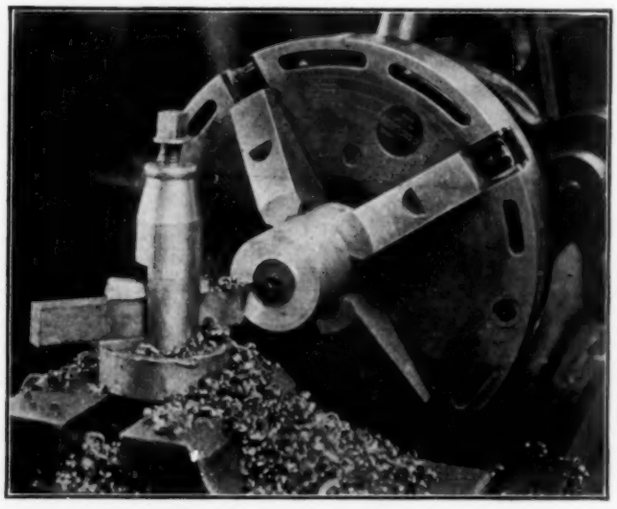


FIG. 15. FACING THE SHELL BASE

use any gage. The scheduled output for this operation is 48 pieces per hour.

After the base has been faced, a boy restamps the heat number (which in the facing operation has been effaced from the base) where it was before. It is a simple matter for him to get the number correctly, for it will be remembered that the heat number is on the side of the shell, where it was stamped after the rough-turning operation.

After facing, the work is inspected for squareness with the body and also for length. As previously stated, the blanks are bought from a number of outside producers and are found to vary greatly in length. This variation in some cases runs as high as 3/8 in. From now on the operations, if not actually finishing operations, are more nearly allied to finishing operations. It therefore be-

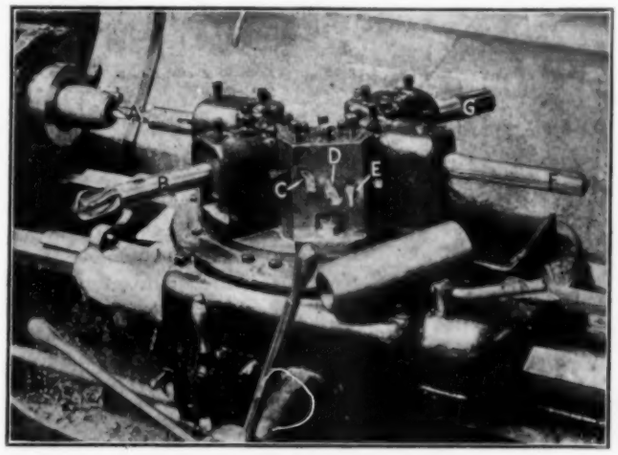


FIG. 16. FINISH BORING ON THE TURRET LATHE

comes necessary to bring the blanks to uniform length. Those blanks which, with the base squared, are of the correct length, pass direct to the boring and reaming operation. Those which are found by the inspector to be too long are checked and transferred by the truck gang to the length-facing operation.

The seventh operation is done on lathes of the same size and make as those used for facing the base. They are equipped in exactly the same manner, except that they have a stop in the chuck for the base of the blank.

The blank is chucked with the base against the stop in the chuck. The tool is an ordinary roughing tool, and with it the operator takes one or more cuts to remove the excess of metal from the nose of the blank. The length gage is the only gage used. This operation takes a little longer than the previous one, and 30 pieces per hour is the scheduled production. After passing inspection for length and being tallied to the credit of the operator, the truck gang takes the work to the boring and facing operation.

The eighth operation is the first of the finishing operations and consists in finishing the hole to diameter and depth, cutting the annular recess at the rear of the location for the nose thread, turning the check on the outside of the end and finishing the angle on the inside of the nose.

This is one of the jobs on which the turret lathe has been retained, and it requires altogether seven tools and five turret stations for completion.

The work is held in the regular Jones & Lamson collet chuck. The first tool used is the twist drill *A*,

*Previous installment appeared on page 1. Copyright, 1916, Hill Publishing Co.

Fig. 16. The size of this drill is of no great consequence; any drill about 5/8 in. in diameter will do, as its work consists merely in removing the metal in the center to nearly the finished depth of the hole. The drill is carried in an ordinary socket in the turret.

The second turret station carries the reamer *B*, also shown in Fig. 17. It is in reality a four-fluted roughing

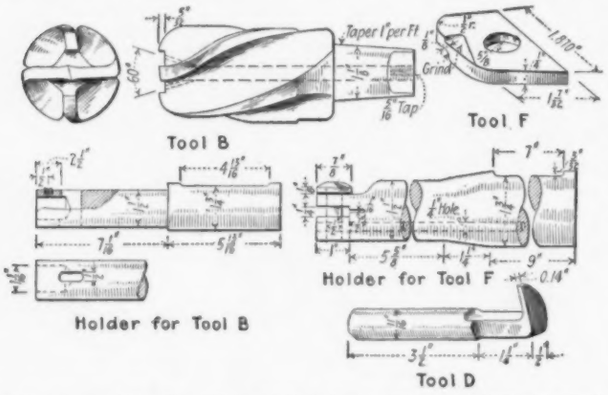


FIG. 17. SOME OF THE TOOLS FOR THE FINISH-BORING OPERATION ON THE TURRET LATHE

reamer that is provided with one pair of end-cutting lips to remove the metal at the end of the hole to the depth cleared by the twist drill. The same reference letters are, for clarity, used in the illustrations and in the operation sheet.

The third station of the turret carries three tools. The tool *C* turns the bevel on the inside of the nose. The tool *D* cuts the recess inside the shell at the point which will later be the extreme end of the thread. The tool *E* turns the check on the outside of the nose. It will of course be understood that the headstock is fed over for these cuts. The fourth station of the turret carries the finish-boring tool *F*, which is also shown in Fig. 17. This tool finishes the bore and faces the end of the hole. The

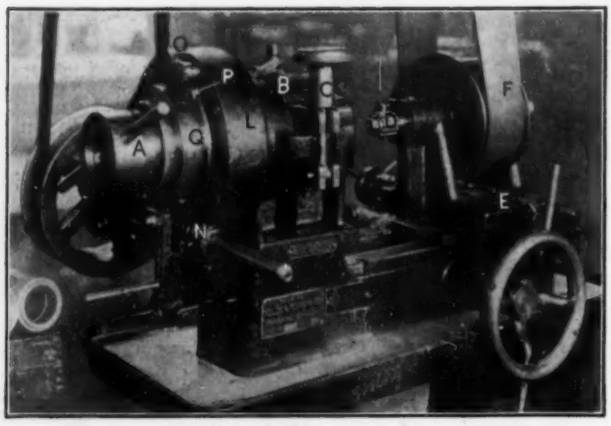


FIG. 18. NOSE THREAD MILLING MACHINE

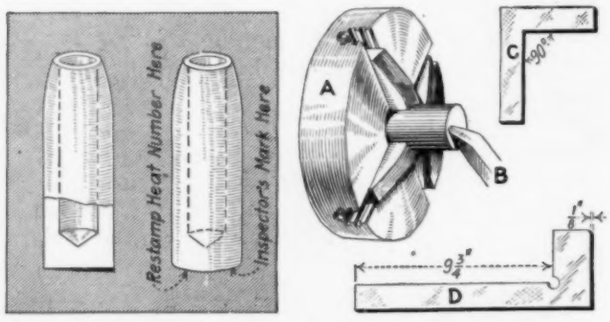
fifth station carries a Pratt & Whitney adjustable reamer that finishes to size the part of the bore which later will be threaded. This completes the eighth operation. The scheduled time is 10 pieces per hour. When the operator removes the finished work from the chuck he inverts it over an air jet, turns the air on and blows the chips out.

The inspector tests the work as shown in the eighth operation sheet. After passing inspection the work is marked as indicated, credited by the checker to the operator, and the truck gang delivers it to the next operation.

The ninth operation is threading the nose. In some shops this is done with collapsible taps, in others with solid ones; but in this shop it is done on Holden-Morgan thread-milling machines, one of which is shown in Fig. 18. While the principle of this machine is very old it is not commonly known, and a short description may be of interest.

The spindle of the machine is of sufficient size to take the shell inside it. The forward end of the hole in the spindle is conical, acts as a seat for the nose of the shell and centers it. At the rear end the hole in the spindle is threaded to accommodate the threaded plug *A*, Figs. 18 and 19. This plug at the forward end is also coned on the inside and performs the same office with regard to the rear end of the shell as the coned front end of the spindle does with regard to the nose of the shell; that is to say, it seats and centers the base of the shell.

The foregoing is the way in which the machine is supposed to work. No doubt good results could be obtained with it if the shells were accurately finished on



OPERATION 6: FACE THE BASE SQUARE WITH THE BODY
Machines Used—20 in. by 6 ft. engine lathes.
Special Tools and Fixtures—Heavy combination chuck A; roughing tool B.
Gages—Length gage D, square C.
Production—One man and one machine, 48 pieces per hour.
Note—Cutting compound used.
References—Fig. 16, and for inspector's mark, Fig. 10.

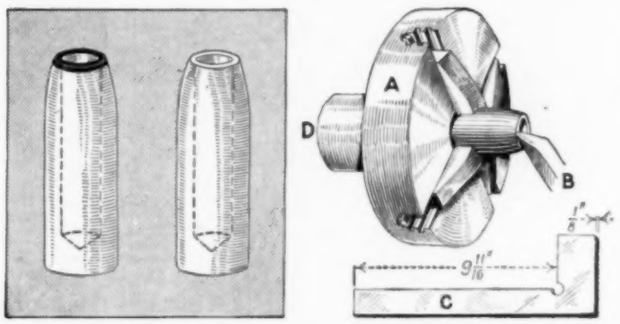
the outside before being chucked in the spindle. It must, however, be remembered that the rough-turned nose contour is one of the seating points in the spindle. Because of the rough nature of the work on the exterior of the nose, it was found that duplication in the threading operation was impossible. However, in the eighth operation the check on the outside of the shell was finished to accurate dimensions and concentric with the bore, so this was taken as a locating point for the forward end of the shell. The spindle of the thread-milling machine was arranged so that it would clear the shell contour *R*, as shown in Fig. 19, at *S* in the small broken section. A plate *T* was then screwed to the forward end of the spindle *S* and acted as a seat for the checked end of the shell. The other end of the shell was centered by the plug *A*, as previously described. This method has resulted in accurate work and very few discards.

The exterior of the spindle of the machine, with the exception of a short section about midway of its length, is a plain cylinder without flanges, so that it is free to slide endwise in the bearings at each end of the main head of the machine. About midway between the bearings the spindle has an external thread. This thread is of the same pitch and "hand" as the one it is intended to mill in the nose (or base recess) of the shell. Between the bearings is a half-nut *B*, which is fitted to a slot running from front to back of the machine at right angles to the

axis of the spindle, so that it has no side-play in relation to the head, that is to say, in line with the spindle axis.

This half-nut *B* is hinged at the back; at the front there are a swing-bolt and a nut *C* to clamp it in operation position in mesh with the thread *K*, Fig. 19, when it is desired to cut a thread.

The hob *D* consists of what is virtually a stack of disks of the shape of the standard Whitworth thread 14 pitch. In other words, it is a Whitworth screw without lead. In appearance, with the exception of having no lead, it is just like an ordinary hob, is fluted and has cutting clearance; in some cases, to afford extra chip space, it is provided with the type of teeth used on the Eccles tap. In length it is a thread or two greater than the length of the female screw it is to cut. It is mounted on the carriage *E*, which affords it lengthwise motion to permit it to be moved in and out of the hole in the nose, crossfeed to obtain the correct depth of thread, and clamps so that



OPERATION 7: FACE TO LENGTH

Machines Used—20 in. by 6 ft. engine lathes.
Special Tools and Fixtures—Heavy combination chuck A; roughing tool B; stop D.
Gage—Length gage C.
Production—One man and one machine, 30 per hour.
Note—Cutting compound used.
References—Set-up is similar to that shown in Fig. 15.

when located in cutting position it can be rigidly held. The spindle that carries it is driven by the belt *F*.

In order to avoid confusion, the same reference letters are used wherever possible in Figs. 18 and 19, which show the spindle, work and hob.

The spindle *G* carries the work *J*, as shown, between its conical forward end and the internally coned plug *A*. The midlength of the spindle at *K* is threaded 14 per in. right-hand Whitworth, and with it the hinged half-nut *B* is capable of engagement. Covered by the gear guard *L*, in Fig. 18, is a worm gear *M*, Fig. 19, which is driven by the worm *N*, Figs. 18 and 19. If the spindle *G*, with the half-nut *B* in engagement with the screw *K* on the spindle, be rotated in the direction of the single headed arrow, the spindle and inclosed work will travel in the direction shown by the double-headed arrow. As the thread *K* is 14 per in., one turn of the spindle will therefore advance the spindle and work $^1/_{14}$ in. to the right.

Assuming that the hob *D* has but one thread-shaped disk, a single thread would be cut on the inside of the nose by it. But the hob *D* is made up of a number of thread-shaped disks; and a single turn of the spindle accompanied by a uniform advance of one thread results in the cutting of a multiple of single threads, one for each thread-like disk, which on completion of the single turn of the spindle merge into each other and form one continuous thread. The worm *N* is readily disengaged from the wormwheel; on completion of the single turn necessary to complete the thread in the nose of a shell, it is automatically tripped and drops out of mesh.

It will be noticed that there is a pawl *O* at the rear of the gear guard *L*. There are also two oppositely disposed ratchet notches on the rim *Q*, which is secured to the spindle. When the operator starts to unscrew the plug *A* the pawl *O* is in the position shown in

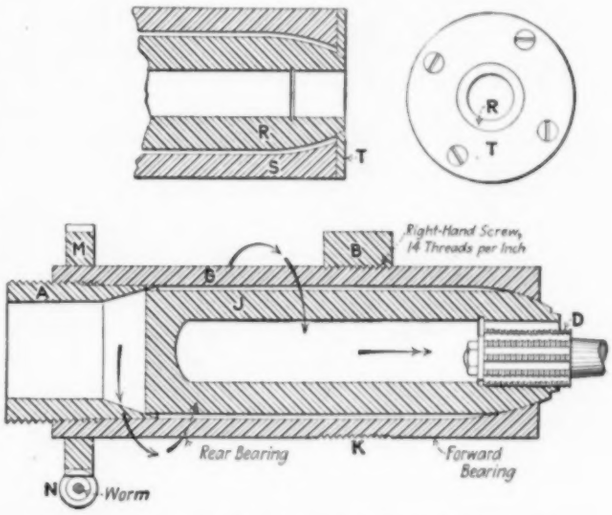


FIG. 19. SPINDLE OF NOSE-THREAD MILLER

Fig. 18. The tooth with which it is in engagement when in this position acts as a stop for the rotation of the spindle at the finish of the hobbing of the thread. The friction of the plug in the spindle is greater than the friction of the spindle in its bearing and in the half-nut *B*. Therefore when the operator turns the handles on the plug *A* in the direction necessary to unscrew it from

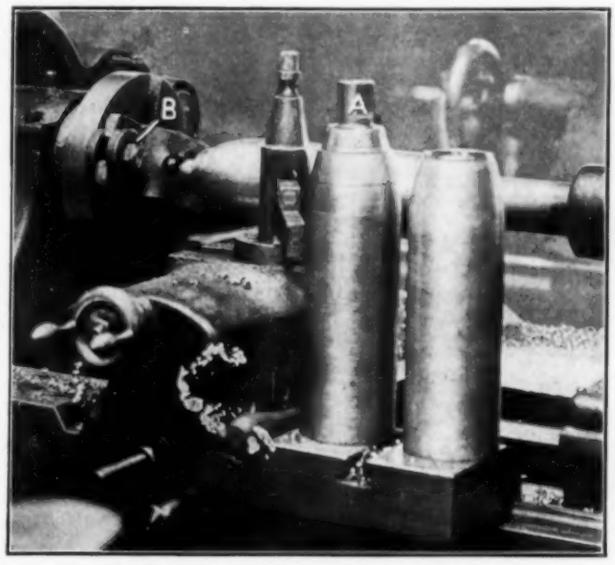


FIG. 20. FINISH TURNING THE BODY

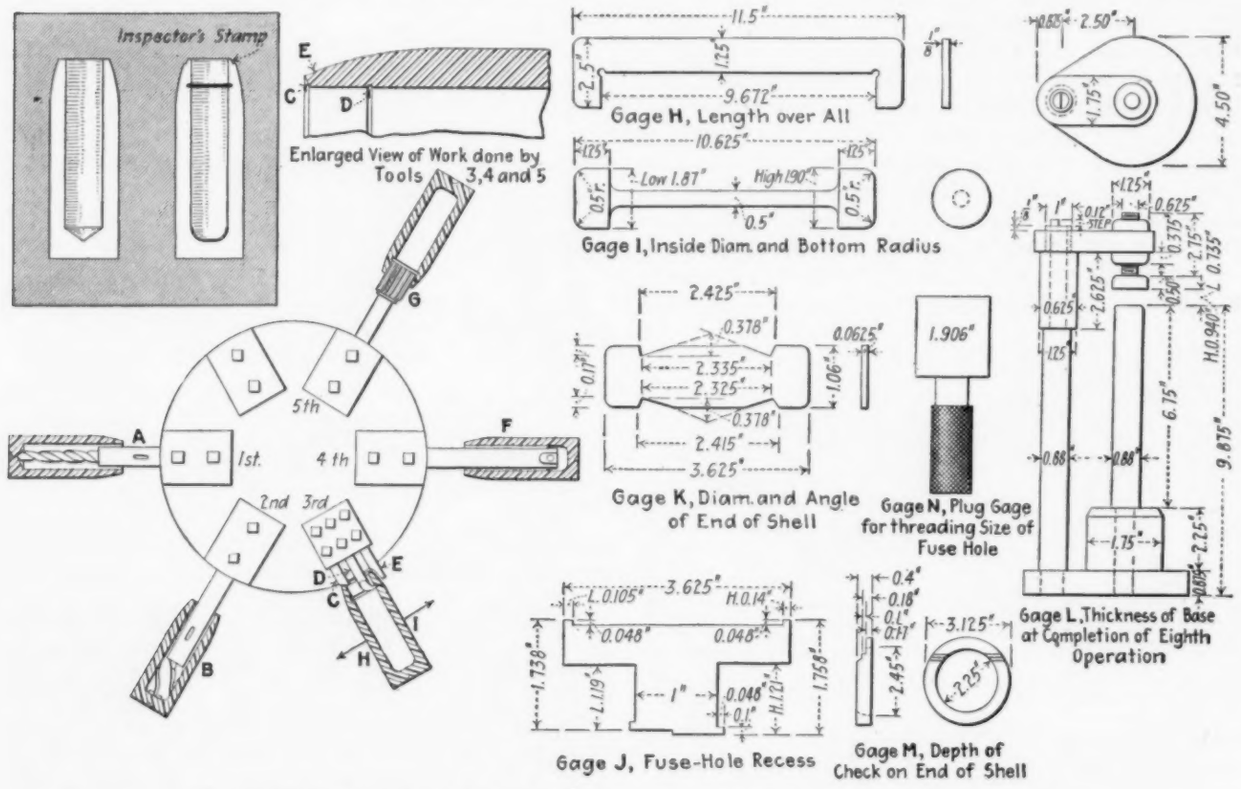
the spindle, this excess of friction between the spindle and the plug causes the spindle to turn with the plug. When nearly one turn of the spindle has been made the operator reverses the pawl so that it will drop into the notch *P* when it comes around, and hold the spindle. After the pawl has dropped into the notch *P*, further turning of the plug *A* releases it from the spindle. It is

then taken out and the work removed. The complete turn, in the reverse to cutting direction, thus taken by the spindle brings it back to starting position for the next thread.

Both slides of the carriage *E* are controlled by stops, and once these are set the operator merely has to place and remove the work. The cross-slide is set so that the hob cuts a thread 0.002 under size, the final sizing of the thread being done later with a hand tap.

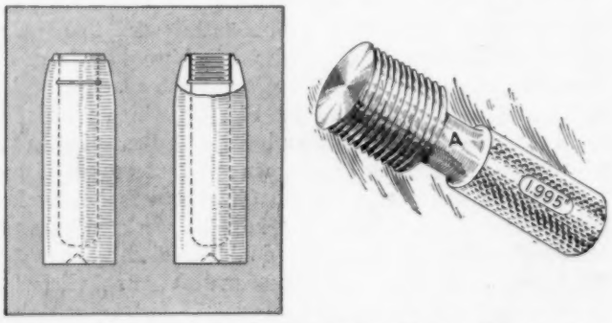
The operation of threading the nose of a shell is as follows: The pawl *O* is dropped into the notch, as shown in Fig. 18; the operator inserts a shell into the spindle; the plug *A* is screwed home, the pawl *O* holding the spindle against turning while the plug is screwed in tight. The carriage is then racked along the bed till it strikes the stop which determines the distance that the hob reaches inside the hole. The carriage is then locked in this position. With the hob rotating, the cross-slide is fed toward the operator till the cross-slide stop is reached. This signifies that the hob is cutting the full depth of thread. The cross-slide is clamped in this position. The pawl *O* is now lifted and the worm *N* raised to throw it into mesh with the wormwheel *M* and thus start the spindle rotating. As soon as the spindle starts, the pawl *O* is dropped, on the same side of the axis of the spindle as it is in Fig. 18; as the notch has by now passed, the end of the pawl rides on the rim of the flange *Q* until the spindle has made one complete revolution, when it again drops into the same notch in which it appears in Fig. 18 and stops the rotation of the spindle and contained work. The scheduled time for threading is 25 pieces per hour, but as high as 29 has been done.

The inspection is with a plug thread gage 0.002 in. under size, which must be a snug fit. There is no inspection stamp for this operation. The machines do excellent work, and out of 600 pieces inspected perhaps there will be one that is too loose and two or three that are too small. This latter fault is of course amenable to correction.


Inspector's Stamp
Enlarged View of Work done by Tools 3,4 and 5
Gage H, Length over All
Gage I, Inside Diam. and Bottom Radius
Gage K, Diam. and Angle of End of Shell
Gage N, Plug Gage for threading Size of Fuse Hole
Gage L, Thickness of Base at Completion of Eighth Operation
Gage J, Fuse-Hole Recess
Gage M, Depth of Check on End of Shell
1st.
2nd
3rd
4th
5th

OPERATION 8: BORE, REAM, RECESS AT END OF THREAD, AND CHECK OUTSIDE

Machines Used—3x36 Jones & Lamson flat turret lathes.
Special Tools and Fixtures—Twist drill and holder A; roughing reamer B; beveling tool C; undercutting tool D; outside checking tool E; finish reaming and bottom forming tool F; sizing reamer G for thread space.
Gages—Gage H for length; gage I for inside diameter and bottom rad; gage J, fuse hole recess; gage K, diameter and angle of end of shell; gage L, thickness of base; gage M, depth of check on end of shell; gage N, plug gage for threading size of inside of nose.
Production—One man operating one machine, average 10 shells per hour.
Note—Cutting compound used.
References—Figs. 16 and 18, and for inspector's mark, Fig. 10.



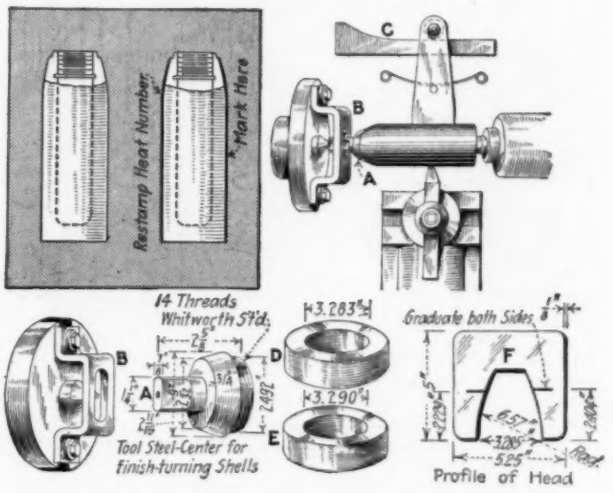
OPERATION 9: MILLING THE INTERNAL THREAD IN THE SHELL NOSE

Machines Used—Holden-Morgan thread millers.
Special Tools and Fixtures—None.
Gage—Plug thread gage A.
Production—One man and one machine, 25 noses threaded per hour.
Note—Cutting compound used.
References—Figs. 18 and 19.

After crediting to the operator by the checker, the truck gang conveys the work to the following operation.

The tenth operation is finish turning, shown in Fig. 20. It is done on engine lathes of 16- and 18-in. swing, with 6-

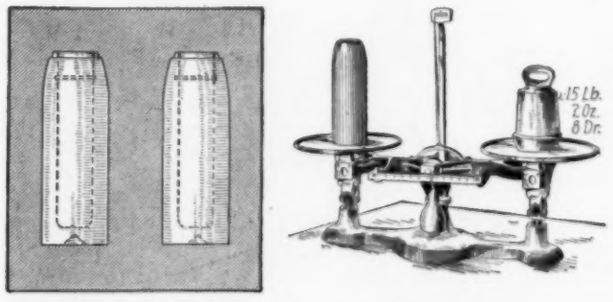
and 8-ft. beds respectively. The threaded plug and driver *A*, shown in detail in the tenth operation sheet, is screwed into the nose of the shell. Secured to the driver plate of the lathe is the slotted female driver *B*, which receives the flattened end of the driver *A*. The base end of the shell is supported on the tail center. At the back of the



OPERATION 10: FINISH TURNING THE SHELL BODY

Machines Used—Engine lathes, 16 and 18 in. swing.
Special Tools and Fixtures—Plug driver A; female driver B attached to small faceplate; former and roller C at the back of the lathe.
Gages—High and low body diameter gages D and E; profile of head F.
Production—One man and one machine, 20 per hour.
Note—Cutting compound used.
References—Fig. 20, and for location of inspector's mark, Fig. 10.

lathe is a former similar to the one used in the fifth operation for rough turning the nose; but in this case the former is the full length of the work, and its nose end is toward the headstock. Each operator is supplied with several of the male drivers *A* and also with a vise, as shown in Fig. 5, to hold the shells while inserting and removing the drivers. As the cut is a comparatively long one the operator has ample time during the cut to place and remove the drivers from the work. Here, as in the roughing operation on the nose, the tool is fed to depth by



OPERATION 11: WEIGHING THE SHELLS

Machine Used—Ordinary weighing scales.
Special Tools and Fixtures—None.
Gages—None.
Production—One man and one set of scales can weigh about 100 shells per hour.
Note—About 10 per cent. of the shells are correct weight.
Reference—Fig. 21.

the compound slide. One cut finishes the work. The scheduled time for finish turning is 20 pieces per hour. The operator uses a ring gage 3.290 in. in diameter, which he tries over each piece after it is turned. This is the high limit for diameter. After the piece is turned, a boy restamps the heat number on the shell in the position indicated in the operation sheet, taking it from the base of the shell.

Diameter gages are used on the body, the limits being 3.280 and 3.290 in. respectively. The inspector also gages the shape of the nose with the contour gage. Passing shells are marked as required by the standard marking chart. The work is then credited by the checker to the operator, and the truck gang conveys it to the eleventh operation.

Up to this point in manufacture the shells have been kept as near as possible to the high limits. They now undergo the first weighing operation. The actual weighing is done by an employee of the shop, but the operation is under the eye of a Government inspector. The shells are weighed on ordinary scales, like that shown in Fig. 21, and the amount which they are over 15 lb. 2 oz. 8 dr. is chalked on the side of the shell in ounces and fractions, as shown in the illustration, and an amount of metal equal in weight to these chalked figures must be removed from the base in the twelfth operation.

The scales used seem to be standard for weighing shells, as one sees them in practically all the shell shops. It would, however, seem that this is an ideal job for an automatic scale which would give at a glance the exact over-

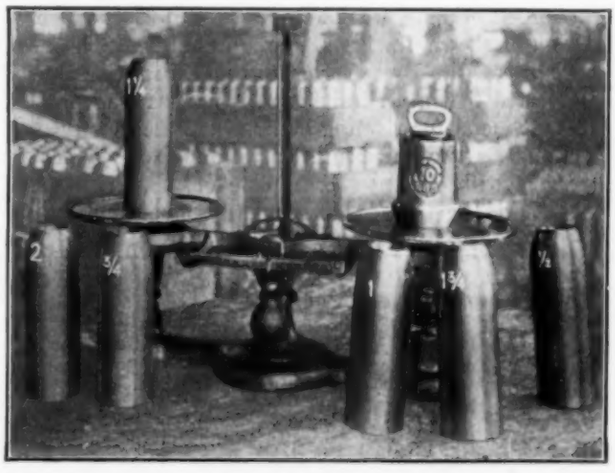


FIG. 21. WEIGHING THE PARTLY COMPLETED SHELLS

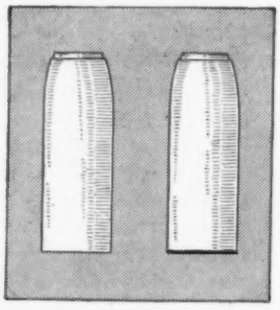
weight or underweight in ounces, and even drams if necessary. With the scale shown in the illustration there is always more or less manipulation of the weights before the weight is ascertained. It is reasonable to believe that one man with an automatic scale could easily weigh as many shells as two with the ordinary scales.

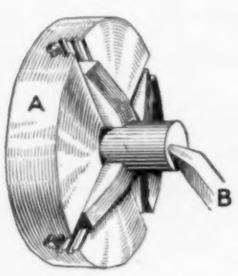
Ranged along the wall close to the weighing department are several 20-in. by 6-ft. engine lathes. They are similarly equipped to the ones used for facing the base, as shown in Fig. 15. They have heavy combination chucks and no tailstock. These are used to face off the excess of metal and bring the shells to the weight specified. One would imagine that the operators on this work would soon become so expert at guessing how much to take off that they would be able to bring the shells to exact weight in one cut. This is, however, not the case, as often several cuts are necessary to secure the weight.

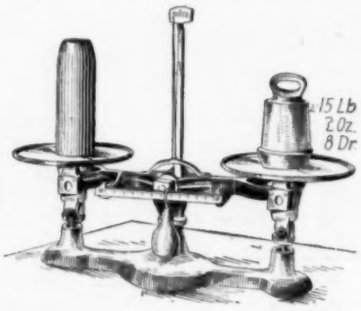
While it is my job to record the operations that have been laid out by others, I venture to suggest that a dial indicator could be mounted in advance of the tool and be so graduated that it would specify the exact cut to take in order to remove a certain weight of metal.

The scheduled output on this facing to weight is 35 shells per hour. Having been adjusted to weight, the shells are taken by the truck gang to the next operation. Facing to weight is day's work, and the operation is not checked.

The first specifications covering the 18-pounder high-explosive shell required that all base plates should be threaded and screwed into the threaded recess in the base of the shell. Before assembling in place they were smeared with Pettman cement, and after they were firmly screwed into the base-plate recess they were riveted in place. This method of sealing the base end of the shell gave more or less trouble. Too much Pettman cement prevented the plates from seating properly. The riveting often resulted in loosening threads which without riveting were a good snug fit. For these reasons the new type of base plate was devised. Both types of base plates are shown in Fig. 3, and the illustration need not be repeated. By referring to this illustration it will be observed that a vertical flange is necessary to provide sufficient metal for riveting over to hold the new type of base plate. The thirteenth operation is one which is necessary with this new base plate only. Those shells which have the threaded base plate do not undergo it.







OPERATION 12: FACE TO CORRECT WEIGHT

Machines Used—20-in. engine lathes without tailstocks.
Special Tools and Fixtures—Combination chuck A; facing tool B.
Gages—The scales act as gages for this operation.
Production—One man and one machine, 35 shells per hour.
Note—This is a complementary operation to operation 11 and the equipment is similar to that shown in Fig. 15.
Reference—None.

in order to bring them to specified weight, been turned slightly varying lengths and will therefore not all project an equal distance from the chuck, some sort of self-accommodating gage is in this operation a manufacturing necessity. The gage *B* fulfills the requirements, is simple in construction and produces results that are sufficiently accurate. The part *B* is secured to the tool slide. Hinged to the top of it is the member *C*, which can be swung out of the way if desired. The forward end of *C* is slotted to accommodate the roller *D*. The angular tool *E* is ⅛ in. nearer the chuck than the roller *D*, thus gaging a cut ⅛ in. deep irrespective of the length of the shell.

The operation of turning the "face angle" (for riveting) is as follows: A shell is chucked, then the operator brings the carriage toward the chuck till the roller *D* touches the face of the base of the shell. With the carriage held in this position the angular tool *E* is fed across the face of the work till the stop is encountered. The scheduled time for this operation is 50 pieces per hour.

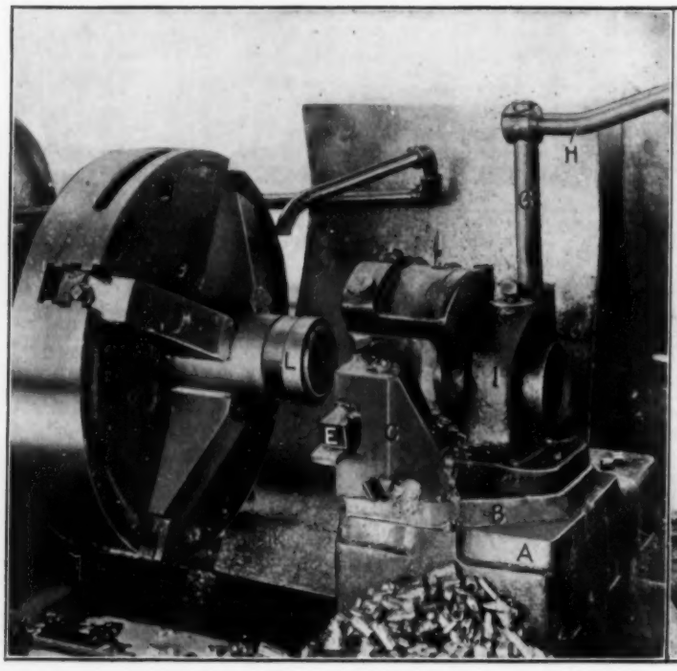


FIG. 23. ROUGH GROOVING FOR THE DRIVING BAND

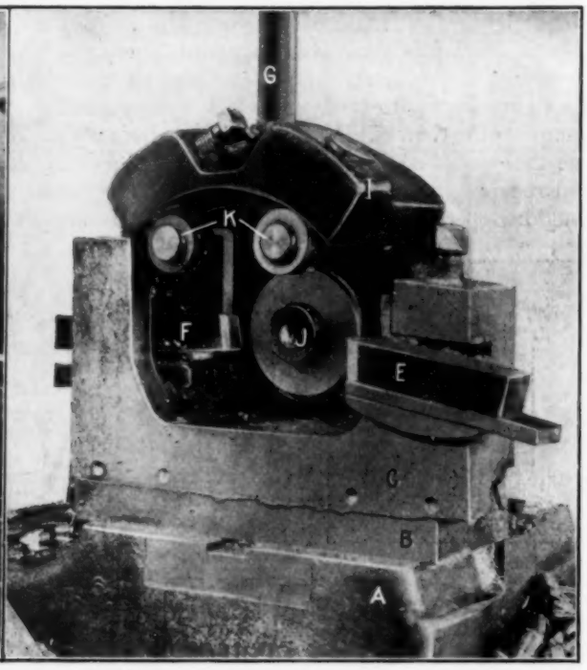
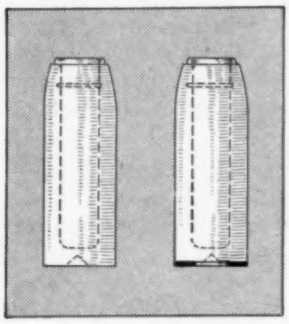


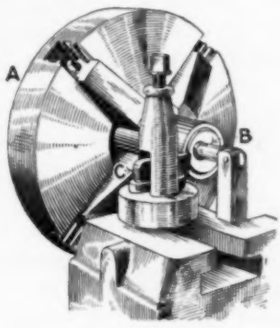
FIG. 24. ROUGH GROOVING TOOLS

The work is done on 20-in. by 6-ft. engine lathes. No tailstock is used. The arrangement is as shown in Fig. 22. The shell *A* is gripped in a heavy combination chuck, the nose of the shell bringing up against a stop. Owing to the fact that the shells in the twelfth operation have,

The shop inspection for the thirteenth operation consists in gaging the riveting angle with a sheet-steel gage. Having passed inspection, the work is checked and credited to the operator, and the truck gang transfers it to the next operation.

The fourteenth operation is rough turning the groove for the wave and rounding the edge of the base. This work is done on 20-in. by 6-ft. engine lathes with a special





OPERATION 13: TURN THE RIVETING FACE ANGLE ON THE BASE OF THE SHELL

Machines Used—20-in. engine lathes without tailstocks.
Special Tools and Fixtures—Combination chuck A; compensating gage B; angular tool C.
Gage—Angle gage D.
Production—One man and one machine, 50 shells per hour.
Note—Cutting compound used.
Reference—Fig. 22.

set-up of tools, as shown in Figs. 23 and 24. Similar reference letters will be used wherever possible in these two illustrations in order to avoid confusion.

Mounted rigidly on the cross-slide of the lathe is the block *A*. It is connected with the crossfeed screw, but for the purpose of crosswise adjustment only. Once the

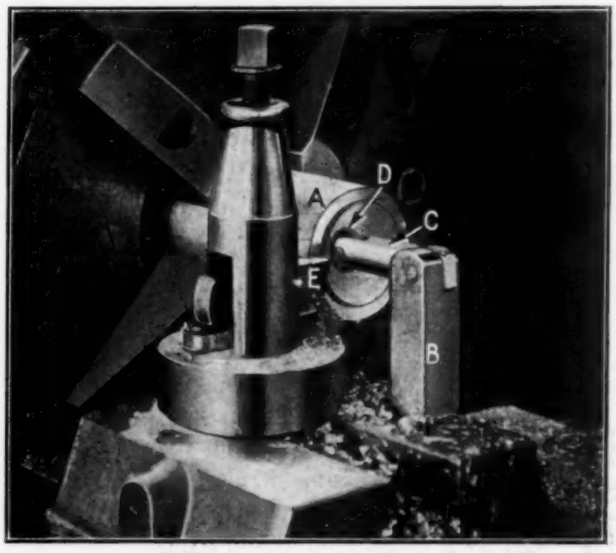
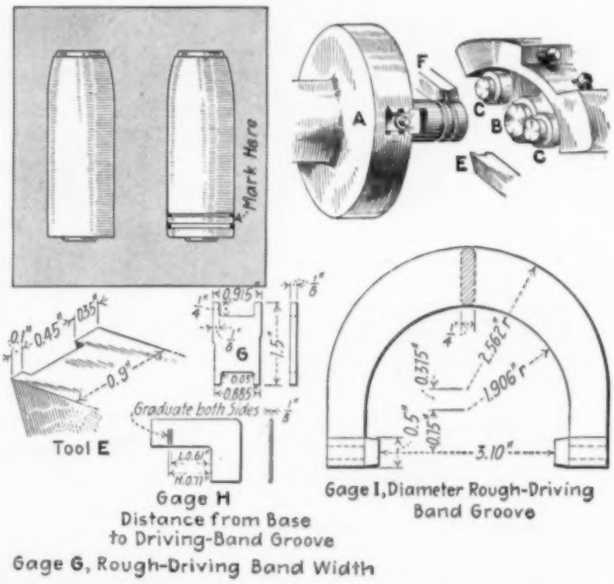


FIG. 22. TURNING THE RIVETING ANGLE

block *A* is set in the correct position, the crossfeed handle is removed and the gib screws are set up hard to prevent shifting. Rigidly secured to the top of *A* is the fixture *B*. Sliding crosswise on *B* is the member *C*, which carries at the front the rough groove-forming tool *E* and at the back the edge-rounding tool *F*, which is shown in Fig. 24. The sliding member *C* is provided with a rack that is engaged by a pinion on the lower end of the shaft *G*. A lever *H* controls the movement of the slide *C*. Rigidly secured to *B* is the member *I*, which acts as a housing for the shaft *G* and also carries the stop *J* and rollers *K* that bear on the plain part of the shell behind the groove and prevent it from lifting during the grooving operation.

The operation of cutting a groove is very simple. The shell is chucked, and the carriage is brought forward till the stop *J* bears on the base of the shell, thus determining the distance from the base to the groove. The carriage is then clamped, and the operator pulls the lever *H* toward him till the stop for the grooving tool is reached. He then pushes it away from him till the stop for the edge-



OPERATION 14: ROUGH TURN DRIVING BAND GROOVE AND ROUND EDGE OF BASE

Machines Used—20-in. engine lathes without tailstocks.
Special Tools and Fixtures—Combination chuck A; fixture on saddle holding the stop B and rollers C; cross-slide carrying the grooving tool E and edge-rounding tool F.
Gages—Rough driving band groove gage G; distance from base of driving band, gage H; gage for diameter of driving band groove I.
Production—One man and one machine, 35 shells per hour.
Note—Cutting compound used.
References—Figs. 23 and 24.

rounding tool is encountered. The first movement roughs the groove, and the second rounds the edge of the base. The carriage is now unclamped and run back and the work removed.

The scheduled time for the fourteenth operation is 35 pieces per hour. The shop inspection covers the diameter of the driving-band groove in the rough, the limits for which are 3.090 and 3.110 in. However, but a single gage is used here, 3.100 in. in diameter. The distance from the base to the driving band is between 0.73 and 0.77 in., but the high limit alone is used. The width of the driving-band groove in the rough, is between 0.885 and 0.915 in.

After inspection the shell is marked as specified in the standard marking sheet, shown in Fig. 10, the checker makes the necessary entry of credit to the operator who has done the work. The next move is up to the transportation department and consists in trucking the work to the succeeding operation.

(To Be Continued)

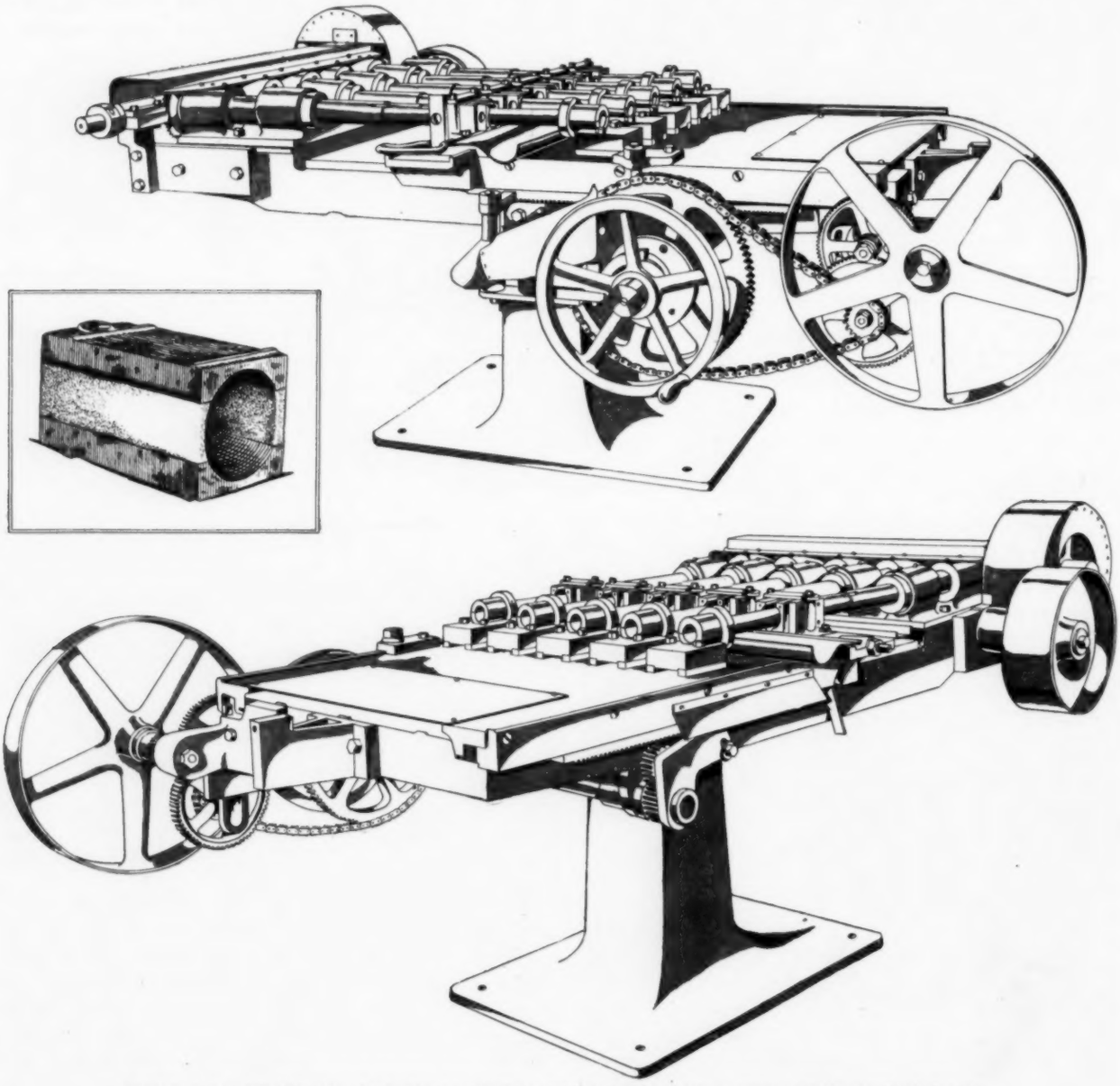
Special Machine for Boring Magneto Pole Boxes

In the manufacture of magnetos the pole box represents a part on which rapid production is necessary in order to maintain the high output now so common in this class of manufacture. Too meet these conditions the Henricks Magneto and Electric Co., Indianapolis, Ind., has designed and manufactured a special machine, shown in the illustration, for boring pole boxes.

These parts are made of two cast-iron shoes with babbitt filling pieces, the fixture used when uniting or pouring them being shown in Vol. 43, page 1065, and a dimensioned detail on page 1066. The base of the machine measures 22x30 in., with a flange of ¾ in. The column of the base is 9x7 in., and it stands 21 in. high from the floor to the under side of the table.

The table measures 31x37 in. and is made of metal 1 in. thick. The feed pulley is 18½x2¼ in. wide and operates through a 1¼-in. pitch silent chain. There are five spindles on the machine, each 4¼ in. long. The pilot ends of the spindles are 1¼ in. in diameter and 3 in. long. The guideways of the spindle bearings are ¾ in. wide and 5½ in. long.

The feed of the machine is by a rack of ⅜-in. pitch, with a 1¼-in. face. The driving pulley is 11¾ in. in diameter and has a 4-in. face. It operates the machine through 4-pitch tooth gearing with 2½-in. wide faces. The shafts on which these gears are mounted are 1⅜ in. in diameter. The large gear driven by the driving pulley revolves at 73 r.p.m., and the spindles operate at 39 r.p.m. The feed of the machine is 1 in. per minute, and the average production of boxes bored is 30 per hour.



SPECIAL MACHINE FOR BORING MAGNETO POLE BOXES ON A HIGH-PRODUCTION BASIS

This machine is an excellent example of the design of a multiple-spindle special machine tool intended to produce a single part under the most advantageous conditions. The result of the design is a machine which bears no resemblance to any standard machine tool, yet it probably represents the highest type of development for the purpose for which it was constructed.

Getting "Into" the Small Shop

By John H. Van Deventer

SYNOPSIS—Some customers have developed highly efficient ways of working up a fictitious credit, with the object of "putting one over" on the small shop when the time is ripe. This article relates one such instance, which had the effect of closing the doors of a small marine repair shop. Incidentally it introduces the reader to Dave Hope, the Knight-Errant Machinist.

"Rivet a washer on the end of your cold chisel, Sonny!" Dave Hope addressed this bit of advice to the new apprentice, whose hand was swollen to twice its natural size as the result of well-intentioned but misaimed hammer blows. The lad has passed the stage of looking for left-hand monkey-wrenches and of being sent from machine to machine in search for the key of the big planer, and was now learning the rudiments of chipping. Dave Hope's repair shop was a good place in which to learn this art, for there were plenty of castings to chip, and hardly any two of them were alike. Incidentally it was a great privilege for a boy to learn his trade in Dave's shop, for its owner was a real "all around" machinist, and an apprentice trained by him was able to use both head and hands when he stepped out of his time.

It will not be amiss to introduce Dave to you with a description of the man and a brief outline of his checkered career, for it is my hope to be able to recount from time to time during the year some of the most interesting of his adventures in small shops. Please overlook the single grimy finger that he extends you in greeting, and grasp him by the hand, for I know that *American Machinist* readers will not hesitate because of the signs of honest toil that are upon it.

Dave is one of those men whose age it is hard to tell from his appearance. The youthful expression of his face seems to contradict the evidence presented by his white hair and mustache, and his tall, somewhat spare figure is as active as that of a man of 30. He started to serve his time in a railroad repair shop when a boy of 12, in the days when a railroad-shop apprenticeship meant a much more varied experience than it does at present. A few years of knocking about the country followed this, during which he carefully avoided the big "manufacturing shops," for Dave, as he says himself, "never did have a liking for doing the same thing twice."

Dave Hope, the Knight-Errant Machinist

One fairly large repair shop in the West Virginia coal fields held him for 18 months—not because Dave was beginning to settle down, but because he had a good paying job as foreman, and board was cheap. He was beginning to get the "shop of his own" idea, and this seemed like a good chance to get the necessary money to start with. It was while here that Dave Hope's hair turned gray, due to being caught by a "fall" while directing the installation of a receiver on an air line in the lower level. Three days in darkness after the safety lamps burned out left their physical effect upon him, but seemed to make no impression on his spirit; or if any, it was to strengthen his disregard of danger or obstacles standing in the way.

Then began his adventures with small shops of his own—many of them, but one shop at a time—most of them disastrous financially, for Dave is no "captain of industry," but rather a "knight-errant machinist" who loves to venture where those seeking more substantial return fear to tread. And while he has attended the obsequies of more defunct plants than any other man of my acquaintance, the funeral services are scarcely over before you find Dave installed in another shop in which he does what he pleases in the way that suits him best. While these many changes have kept him rather poor in pocket, they have made him rich in experience and character, and as a curious result he has a sort of camp following among those who work for him. Thus as I leaned against the bench and heard him deliver the foregoing words of advice to the apprentice, I could pick out among those working about the shop, faces which I had seen both in his shop in Philadelphia and in the one in Kansas City, where our acquaintance began.

The Kind of Experience That Sticks

"That kid with the sore thumb is getting experience," remarked Dave. "We all get it that way, and it's the only way that seems to stick. Life is a series of bumps from the time you slide off the first step till you hit the bottom landing. It's all in getting used to it. You can even get so you like it, as the boy did who had the measles three times. Sometimes it's a money loss, sometimes a machine won't work as you expect, and sometimes a disappointment in human nature. The hardest kind of a bump is when a man you trust goes back on you. I've had a number of such experiences, and while I can look back now and see the funny side of them, the sore spot lasted much longer than it did with the ordinary kind of bumps.

"Maybe it will interest your readers to hear of a lesson I learned about extending credit. I hope other small-shop owners may profit by it, and that it will help some of them to avoid paying the price that I did for this kind of experience.

"If you've been along Long Island Sound during the summer season, you've noticed what a slew of motor boats and steam yachts there are dotting the bays outside of the summer-resort towns. I noticed this about nine years ago, and also that about five boat owners out of seven seemed to have trouble with their motors when they got 50 ft. away from the dock. Of course this wasn't to be wondered at. Many of the owners were clerks from the city who knew as much about taking care of an engine as that green apprentice boy does about swinging a hammer. The boats were mostly hand-me-downs; not merely second hand, but seventh or eighth hand, and in addition the gasoline that those alongshore dealers worked off on that bunch of innocents was so weak that it could hardly run even when the can was turned upside down.

"I didn't have a shop just at that time, and the idea struck me that here was an opportunity that a good mechanic might turn to advantage. This was before the automobile became common, remember, and there were not many machinists in those days who understood the

kinks and troubles of small gasoline motors. At least those that I found in the existing shops along the waterfront didn't know much about them, judging by the work they turned out.

"After looking about for a week or so, I ran across a place that looked good to me. The shop stood up on posts at the water's edge and had a dock of its own. The equipment was nothing to brag about, consisting of two lathes in fair condition, one of 16-in. and one of 18-in. swing, a more or less dilapidated gap lathe built up to swing 48 in., a shaper that had seen better days, a pipe threader and two upright drills. I guess what really attracted me to the place more than anything else was seeing a small boy catch three fine flounders in quick succession from the end of the dock. It looked to me like a good place for a fisherman to locate!

"It was about the middle of June that I came into possession. I managed to get enough cash together to make a satisfactory first payment and started in to get some of the money back. Reddy Burke, that you see over there on the miller, was with me, and so was Sandy McPherson, the fellow with his back turned to us, who is fitting a key at that bench. People were just getting their boats out and quite a bit of overhauling was to be done. A good many of them came to us because they knew we couldn't do any worse by them than the other shops and might possibly do better.

"At first most of the work was on small motors, one and two cylinders, ranging from 4 to 20 hp. We turned out good work on these, and the reputation brought us some of the larger boats and a better grade of work along with it. There was one boat that we couldn't touch. It was the largest craft that anchored at the port, a 90-ft. steam yacht with twin triple engines. It seems that in this world what you can't get is what you want most, and it bothered us a lot to see the work on that boat go to a fellow a quarter mile up the bay, especially as we knew what sort of mechanic he was. The 'Alice,' that was her name, made regular trips across the sound and carried passengers back and forth from the shore resorts on each side.

Alice, Where Art Thou?

"Business kept up pretty good, and by the end of July we had taken in enough over and above expenses to make the second payment on the shop. At this rate we would be clear before the end of the season. Any reasonable man ought to have been satisfied with that, but in spite of it our fingers itched to get hold of the 'Alice' and get a chance at work that was really worth while.

"One afternoon about four, we were all busy in the shop when somebody hailed from the end of the dock. I started out to find what was wanted and saw a short stout fellow climbing out of a dinghy that was tied to one of the spiles at the landing platform. When I got a look at his face I saw that he was Captain Skinner of the 'Alice.'

"'Anybody here that understands high-pressure feed pumps?' he asked.

"It took me about two minutes to explain to the captain that there were three men in our shop who knew more about high-pressure feed pumps than any six that he could find if he offered a reward for them anywhere in the United States. I don't know whether he believed it or not, but he was up against it, so Sandy went out in the dinghy, taking his tool kit with him.

"He turned up again in an hour and a half with some samples of mush that had clogged up the discharge check valve and prevented the pump from doing its work. 'Nothing the matter with the pump,' said Sandy. 'The trouble was with the last butcher that overhauled it and put in cold-water packing!'

"Captain Skinner came to us to have his work done after that, and while all the jobs were small ones, it made us feel pretty good to think that the 'Alice' had had to come to Hope's Marine Repair Shop at last. Nobody could have been any better pay than the captain; he never questioned a bill and settled each one within ten days.

"After the middle of August, work slacked up a bit. Most of the boats would be put up after Labor Day, and the owners were beginning to cut down expenses and get along with motors that would run at all, just as nowadays you see a fine lot of decrepit auto tires displayed in the fall. We hadn't figured on this, and it hurt us more than I cared to admit.

A Job That Looked Like a Life-Saver

"It looked like a life-saver when, the day after Labor Day, Captain Skinner turned up with a three-weeks' job for us on the 'Alice'—nothing less than a complete overhauling of the twin triple engines and all of the auxiliaries. The three of us moved over to the 'Alice' next day with our tool kits, and settled down to three weeks of the hardest work we ever did. All of us had corns on our backs from working in the engine pit.

"At the start of the third week Captain Skinner asked me to try to finish up by the coming Saturday morning. As there was some work waiting for us at the shop, we decided to work overtime nights so as to be sure to clean up by Friday night. By Thursday noon we saw that we would finish within the limit, but we were all three so tired out and short-tempered that we had to invent new cuss words to pay our respects to each other, having exhausted all of the ordinary ones.

"Friday night we turned her over to the captain, everything shipshape and better than new. I figured that there was close to a thousand dollars' worth of time and material on that job, and it was worth every penny of it. The captain wanted to give her a trial spin Saturday morning and insisted that I go along with him to see that everything was all right; but in view of all of the work waiting at the shop this was impossible, so I told him to try her out with his own crew. I was sure of the job and knew it would be all right. I handed him the bill for the work, and he said he would settle next evening if nothing went wrong.

"We went to work at 6 o'clock next morning to catch up with the accumulated work. At 8 o'clock one of the boys looked out of the window and said that steam was up on the 'Alice.' At 8:30 she began to move, and we all rushed to the window to give her a wave for good luck. On she went down the bay toward the outlet, looking as pretty as a picture and making a good two knots more than she had been capable of before we overhauled her. She rounded the headland, and we went back to work feeling that we had done a good job.

"We had; but so had Captain Skinner, for that was the last we ever saw of the 'Alice'!"

Improvements on Shell Tools

By J. H. Moore

One firm that has been turning out a considerable quantity of 18-lb. British shells has experienced trouble in getting the shell base correct as to size and finish, the inspectors being very particular on this point. To make sure that all are similar, the company has designed and built what might be termed a special-purpose grinder,

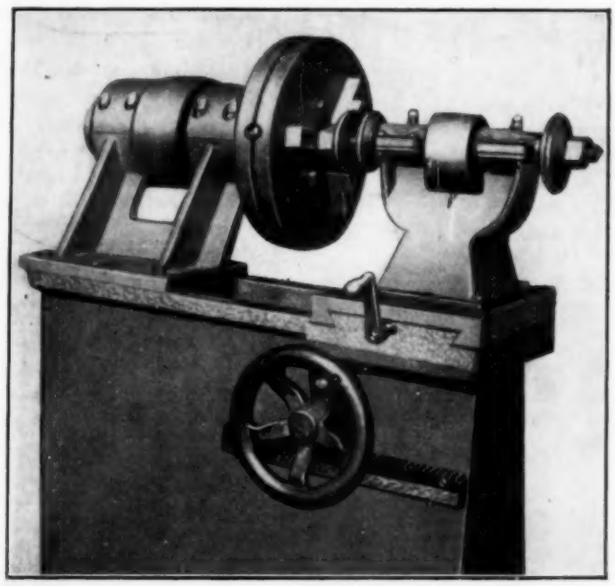


FIG. 1. SPECIAL GUIDE FOR GRINDING SHELL BASES

shown in Fig. 1. The universal-type chuck grips the shell quickly and accurately. The small grinder head is fitted to a sliding apron and holds the wheels that grind both the diameter and the bottom of the shell base. The apron has movement in both directions.

A type of mandrel or boring bar used on the inside work of the shell is shown in Fig. 2. Three operations are done by it—the finishing of the powder-chamber bottom, the facing of the powder-chamber shoulder and the facing of the shell to length. The cutter *A* finishes the bottom of the chamber. Slot *B* shows where the cutter to finish the shoulder goes in, while the four slots *C* show where the cutters for facing off the length are placed. The two last-mentioned cutters have considerable adjustment, and this fact will be appreciated by those

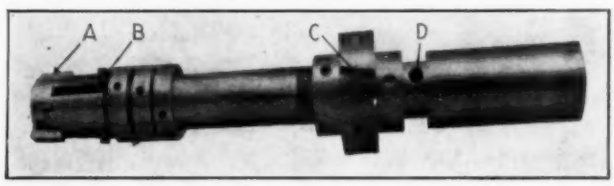


FIG. 2. BORING BAR OR MANDREL FOR COMBINED SHRAPNEL-SHELL OPERATIONS

who have figured on this kind of work. The hole *D* is internal oil feed; and as the bar is hollow, all cutters are well supplied with lubricant.

A handy chuck for shrapnel plugs, which is both quick and extremely accurate, is shown in Fig. 3. The chuck jaws are shown at *A* and are in four parts. A small spring is placed between each jaw. The body *B* is threaded internally and screws on a hub on the flange *C*. The jaws are tapered 18 deg. This is found to be ample to work satisfactorily. To give double driving power to this chuck, a square plug with a round shank is placed

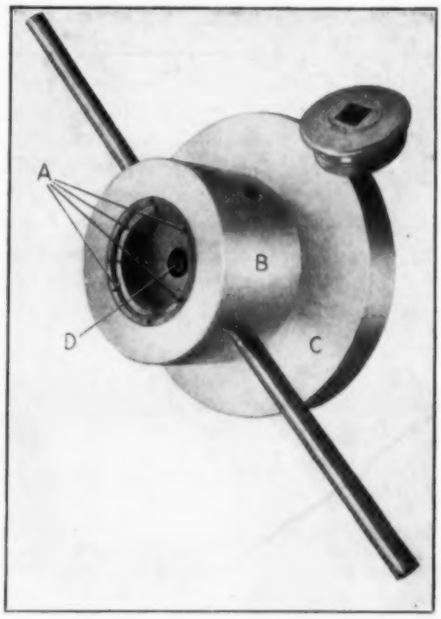


FIG. 3. CHUCK FOR SHRAPNEL PLUGS

in the hole *D*. This plug engages with the square hole in the shrapnel plug and so drives both from this hole and from the outside shell diameter, which is grasped by the chuck.

Conditions of the Machine-Shop Labor Market are shown in a recent report of the New York State Department of Labor. In commenting on manufacturing conditions in general the report states that the greatest improvement was shown by the metal-working industry, which has gained strength all summer, from May to September; and in each month from May to September the industry has shown increasing strength compared with the corresponding months of 1914. The largest increases were shown by concerns manufacturing firearms and automobiles and parts; rolling mills showed but slightly less important gains. The manufacture of brass, copper and aluminum goods, although somewhat less active than in August, showed still in September far greater strength than a year ago. September showed marked improvement also among the group of concerns manufacturing typewriters, instruments and appliances. The only branch of the metal-working industry which is not operating at least as actively as in 1914 is that of fabricating architectural and structural iron.

The Resharpening of Files has only within recent years become commercially successful, according to a paper presented before the International Engineering Congress by E. R. Norris, reviewing generally machine-shop equipment, methods and processes. A sand-blasting apparatus is being used with success for file sharpening by several large manufacturing establishments. This apparatus consists of a sheet-iron chamber provided with uptake, settling tank, slurry mixing-tank, slurry overflow pipe, air agitating pipe and slurry projector. A door gives access to the inside of the chamber. The slurry projector is inclined to the horizontal at an angle of 25 deg., and the nozzle extends slightly within the chamber. This projector consists essentially of a bronze body to which are fitted steam pipe, slurry suction-pipe and nozzle. The steam supplies sufficient water for the slurry. The files are sharpened by being held in the slurry jet in such a manner as to expose the backs of the file teeth to the cutting action of the sand. After the file has been sharpened, it is cleaned and dried by the steam, after the slurry supply has been cut off by a foot lever. Success in file sharpening depends on the skillful selection of the files to be sharpened, maintenance of the correct angle between files and jet while sharpening, and the selection of a suitable sand.

Machining a Two-Sheet Rotary-Press Side Frame

By Robert Mawson

SYNOPSIS—The operations and small tools followed and used in machining a printing-press side frame. The rough casting is first milled on the pads on the outside. Then follow a second milling, boring and drilling operations.

Printing presses are made in comparatively small numbers. The economic effect of this fact is to limit jigs and fixtures to those that are simple in design and construction, and where possible to those that are of such a nature that a number are used in machining one part. The jigs and fixtures shown in this article are from the shop of the Woonsocket Machine and Press Co., Woonsocket, R. I. They are used in manufacturing the side frame of a two-sheet rotary printing press.

The type of the jigs and fixtures shown is what is often called "outside templets." This means that they are simple in construction, inexpensive in first cost and yet produce interchangeable work of the necessary accuracy.

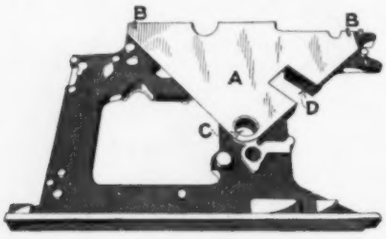


Fig. 2

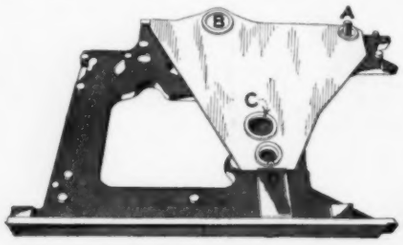


Fig. 3

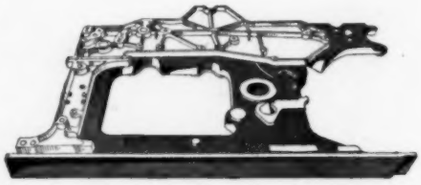


Fig. 4

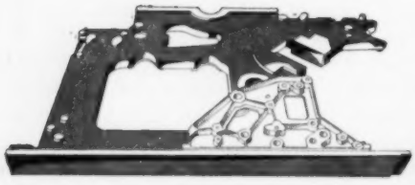


Fig. 5

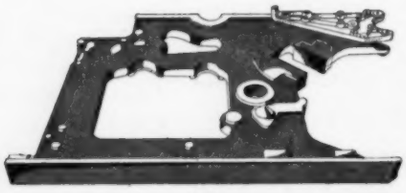


Fig. 6

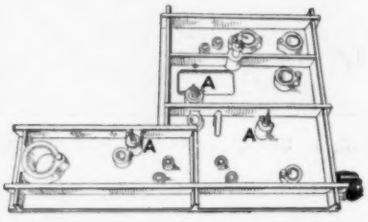


Fig. 8

FIGS. 1 TO 8. PRINTING PRESS SIDE FRAME JIGS AND FIXTURES SHOWN IN PLACE ON THE WORK

FIGS. 2 AND 2-A

Operation—Milling 45-deg. surface to suit gear-bearing box on frame, Fig. 1.

The templet A is placed on the casting, which is fastened to the milling-machine table and adjusted by two screws B until core C is central; the stock left on each side of slot D is surface-machined; slot, using upper edge, the outside face of the bosses and the base, using a 4-in. end mill, operating at 60 r.p.m. and with feed of 0.03 in. per revolution.

FIGS. 3 AND 3-A

Operation—Boring large holes for gear boxes on frame, Fig. 1.

The templet is placed on the casting, located by hardened plates which fit in the machined 45-deg. slot.

Holes Machined—One 4½-in. bore and ream A; one 8-in. bore and ream B; one 6-in. bore and ream C; one 4½-in. bore and ream D.

FIGS. 4 AND 4-A

Operation—Drilling 34 holes in frame, Fig. 1.

The jig is located by two plugs which fit into reamed holes.

Holes Machined—Three $1\frac{1}{32}$-in. drill; one 1-in. drill and ream; three ⅞-in. drill and ream; three ¾-in. drill and ream; one $^{31}/_{64}$-in. drill; two ⅞-in. drill for 1-in. U.S.S. threads; one $\frac{13}{16}$-in. drill for ¾-in. U.S.S. threads; two $1\frac{5}{16}$-in. drill and ream; two $1\frac{13}{32}$-in. drill for 1½-in. U.S.S. tap; two $2\frac{1}{16}$-in. drill and ream; five ⅝-in. drill and ream; one $1\frac{1}{16}$-in. drill and ream; two $1\frac{5}{32}$-in. drill; one ⅞-in. drill and ream; one 1½-in. drill and ream; three $\frac{13}{16}$-in. drill for ⅞-in. U.S.S. threads; one $1\frac{3}{16}$-in. drill and ream.

FIGS. 5 AND 5-A

Operation—Drilling 12 holes in frame, Fig. 1.

The jig is located by a circular plug set in a bored hole and finished; the jig rests on top of the frame.

Holes Machined—One $1\frac{5}{32}$-in. drill; one $1\frac{3}{16}$-in. drill and ream; one ¾-in. drill and ream; three ⅝-in. drill and ream; one $1\frac{7}{16}$-in. drill and ream; one ⅜-in. drill and ream; one $\frac{33}{64}$-in. drill; one 1-in. drill and ream; one 1½-in. drill and ream; one ¾-in. drill and ream.

FIGS. 6 AND 6-A

Operation—Drilling 16 holes in frame, Fig. 1.

The jig is located by a large plug; filling in finish-bored hole; two setscrews tightened to hold it rigid.

Holes Machined—One ¾-in. drill and ream; one ¾-in. drill; two $^{31}/_{64}$-in. drill; one $1\frac{7}{8}$-in. drill and ream; one $1\frac{3}{4}$-in. drill and ream; one ⅞-in. drill and ream; four $1\frac{5}{32}$-in. drill; two ⅞-in. drill and ream; one 1½-in. drill and ream; two $\frac{33}{64}$-in. drill.

FIGS. 8 AND 8-A

Operation—Drilling holes in face of plate cylinder cap, Fig. 7.

The casting is located by a circular plug set in a hole previously reamed. It is held in position with the hook bolts A. All milling has been done in previous operations.

Holes Machined—Five $\frac{7}{16}$-in. drill; two $1\frac{3}{8}$-in. drill and ream; two drill and tap with No. 14-20 threads; four $\frac{13}{16}$-in. drill; one ⅝-in. drill; two $^{37}/_{64}$-in. drill.

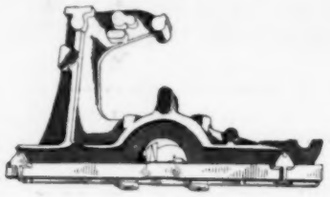


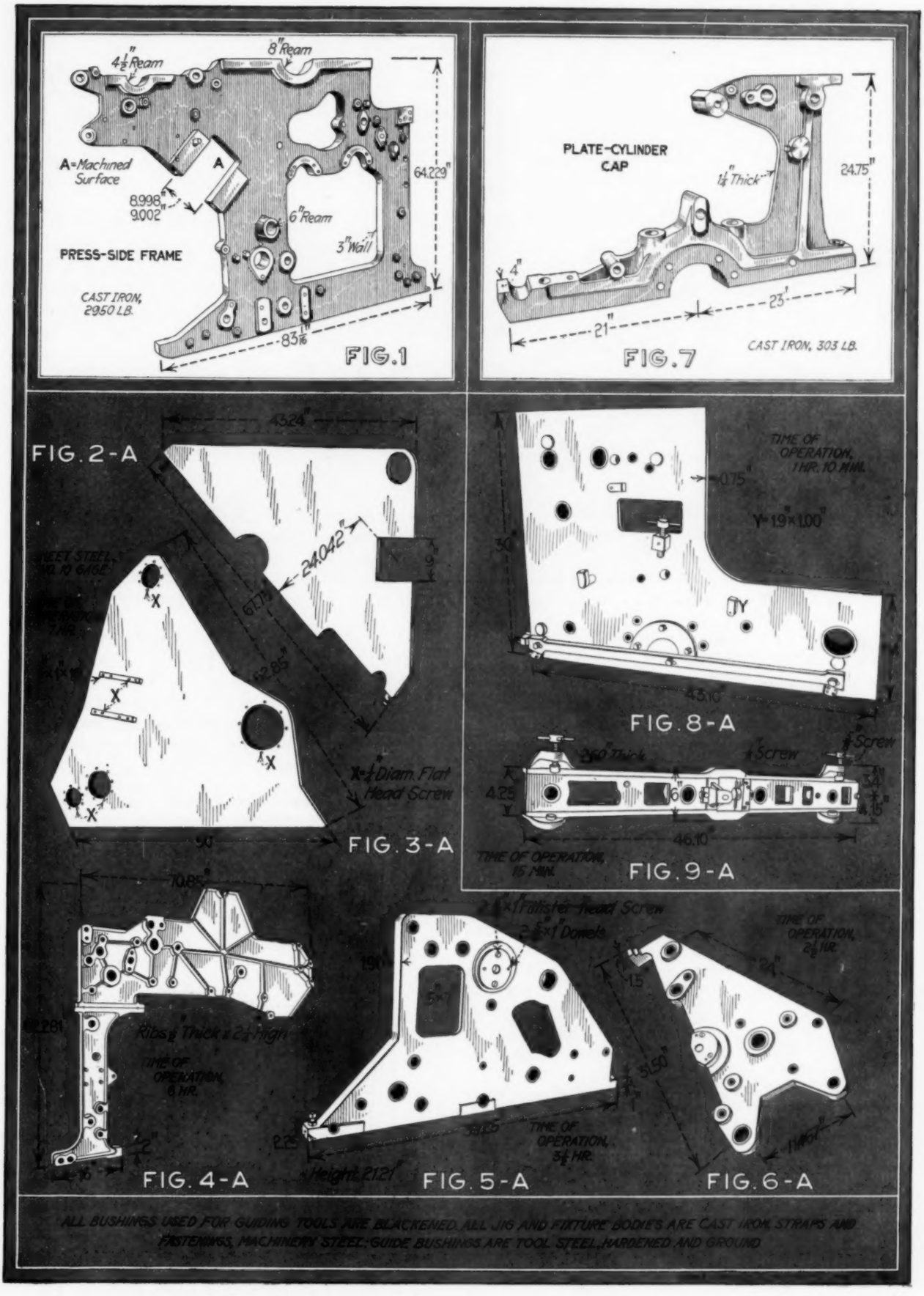
FIG. 9. DRILL JIG FOR JOINT SURFACE

FIGS. 9 AND 9-A

Operation—Drilling holes on joint surface, Fig. 7.

The jig is placed on the milled surface, located by a stop and held in position with screws on the sides.

Holes Machined—Four $1\frac{5}{32}$-in. drill; one ½-in. drill.

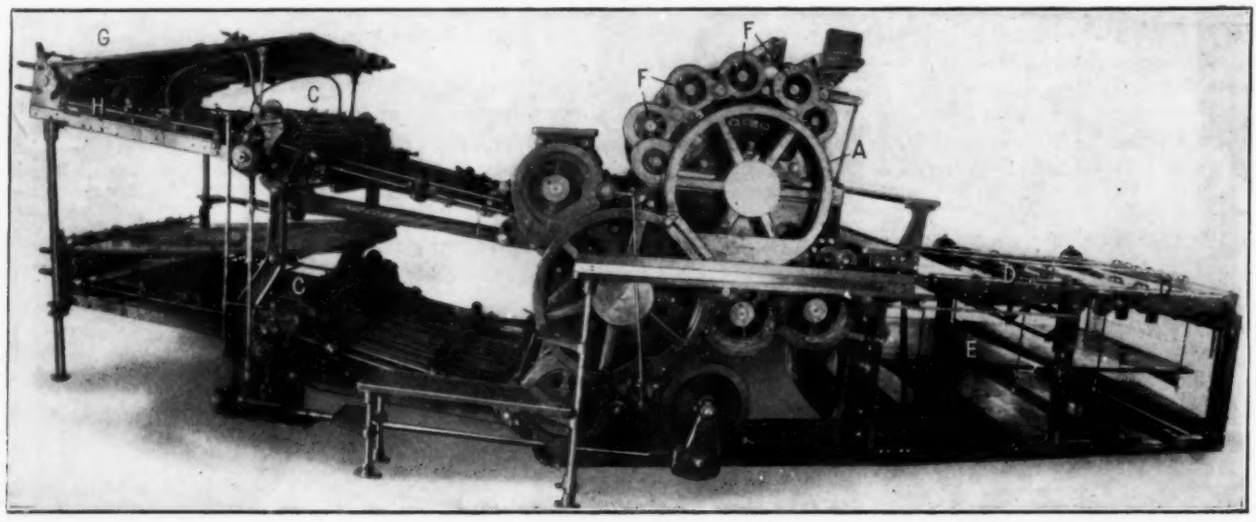


DETAILS OF JIGS USED IN MACHINING PRINTING-PRESS SIDE FRAMES

A Rotary Printing Press

On page 56 is printed the first of a series of articles describing the tools and methods used by the United Printing Machinery Co., Woonsocket, R. I., when manufacturing the press shown on this page.

This machine will print any size of sheet between 29x42 in. and 46x66 in. The press has one plate cylinder *A* and one impression cylinder *B;* the plate cylinder takes two forms and the impression cylinder has two impression surfaces. As there are two automatic continuous feeders *C,* the press will print in one revolution two sheets at a speed of 2,500 per form per hour, or a total output of 5,000 sheets per hour.



A TWO-SHEET ROTARY PRINTING PRESS WITH HIGH-SPEED AUTOMATIC CONTINUOUS FEED

The press has two distinct deliveries *D,* the sheets printed by each form being delivered separately on lowering piles at *E.* The distribution consists of eight form rollers, four 8-in. vibrators *F* and five intermediates.

The adaptability of the press is quite extensive, covering the following combinations: Two forms, one to back up the other; two forms to work and turn; two duplicate forms; two entirely different jobs, providing the ink is the same.

The feeder used on the press is quite interesting, operating somewhat as briefly described. The device automatically feeds the sheets to the machine. It is continuously loaded from above, the paper being placed on the supply table *G.* The paper is drawn from this board to the lower board *H* by passing around the drum. After it is drawn to the proper position on the lower board and the machine is put in operation, the bank of paper is kept in the proper position automatically.

When the machine is started, the combing wheels are lowered and comb the paper forward to the sheet controlling trips. There are two of these that engage the front edge of the sheet, thus bringing it square. Should the front edge of the sheet reach the trips on one side before the other, the opposite wheel will continue to comb until the sheet is brought square.

When the edge reaches the trips, the comb wheels ride up on the comber foot, which acts as a clamp and stops the sheet from advancing farther. A clamp then descends on the bank of paper in the rear of the top sheet and holds the bank in position while the top sheet is withdrawn. With the bank held as described, the combing wheels and feet are lifted and the drop rolls engaged to forward the sheet on the conveyor to the press.

Just before the front edge of the sheet reaches the drop guides the speed of the sheet is checked by rolls grasping the rear end and bringing it gently to the guide without crowding. After the sheet reaches the drop guides a feeler determines if it is in position; if so, the sheet will be engaged by the press grippers and print. If, however, it is not in the correct position, the feeler will automatically trip and stop the feeder.

There is also a device located on the conveyor of the feeder which will allow only one sheet to pass at one time. If more are fed forward, the device will automatically trip and stop the feeder, thus preventing both spoiling of sheets and damage to the form.

Principal Uses for Tungsten Steel, according to a paper read before the International Engineering Congress, are for magnets for magnetos in the manufacture of hacksaws, to some extent, and for special tool steels. Tungsten is seldom used in engineering construction steels and then usually in combination with chromium. The accompanying table shows the typical engineering alloy steels and their tensile properties for the same heat-treatment draw-back temperature. This is in all cases 600 deg. C. (about 1,100 deg. F.). The specimens in most cases were heat-treated in the form of inch rounds and were machined after treatment.

TABLE OF PROPERTIES OF ALLOY STEELS

Carbon, per Cent.	Manganese, per Cent.	Nickel, per Cent.	Chromium, per Cent.	Vanadium, per Cent.	Elastic Limit, Lb. per Sq.In.	Tensile Strength, Lb. per Sq.In.	Elongation in 2 In., per Cent.	Reduction of Area, per Cent.
0.27	0.55	...	...	...	49,000	80,000	30	65
0.27	0.47	...	...	0.26	66,000	98,000	25	52
0.36	0.42	...	...	...	58,000	90,000	27	60
0.34	0.87	...	...	0.13	82,500	103,000	22	57
0.45	0.50	...	...	...	65,000	96,000	22	52
0.43	0.60	...	...	0.32	96,000	122,000	21	52
0.47	0.90	...	...	0.15	102,000	127,500	23	58
0.30	0.60	3.40	...	...	75,000	105,000	25	67
0.33	0.63	3.60	...	0.25	118,000	142,000	17	57
0.30	0.49	3.60	1.70	...	119,000	149,500	21	60
0.25	0.47	3.47	1.60	0.15	139,000	170,000	18	53
0.25	0.50	2.00	1.00	...	102,000	124,000	25	70
0.38	0.30	2.08	1.16	...	120,000	134,000	20	57
0.42	0.22	2.14	1.27	0.26	145,000	161,500	16	53
0.36	0.61	1.46	0.64	...	117,600	132,500	16	58
0.36	0.50	1.30	0.75	0.16	140,000	157,500	17	54
0.30	0.50	...	0.80	...	90,000	105,000	20	50
0.23	0.58	...	0.82	0.17	106,000	124,000	21	66
0.26	0.48	...	0.92	0.20	112,000	137,000	20	61
0.35	0.64	...	1.03	0.22	132,500	149,500	16	54
0.50	0.92	...	1.02	0.20	170,000	186,000	15	45

Notes on Small-Tool Design--III

By Carl D. Wilder

SYNOPSIS—This article treats of small cutters and tools other than the standard ones ordinarily carried in stock. Points, determined from actual experience covering many years in the toolroom, are given for the proper construction of these tools.

Small-tool design is an important item in connection with the design of jigs, but it is often overlooked, because it is so easy to concentrate most of the attention on the jig itself. The illustrations presented are typical of small tools other than standard reamers and mills. It is impossible to give detailed dimensions for these or to do more than deal with the general principles underlying the design, since in most cases they are of special size and dimensions to suit special purposes.

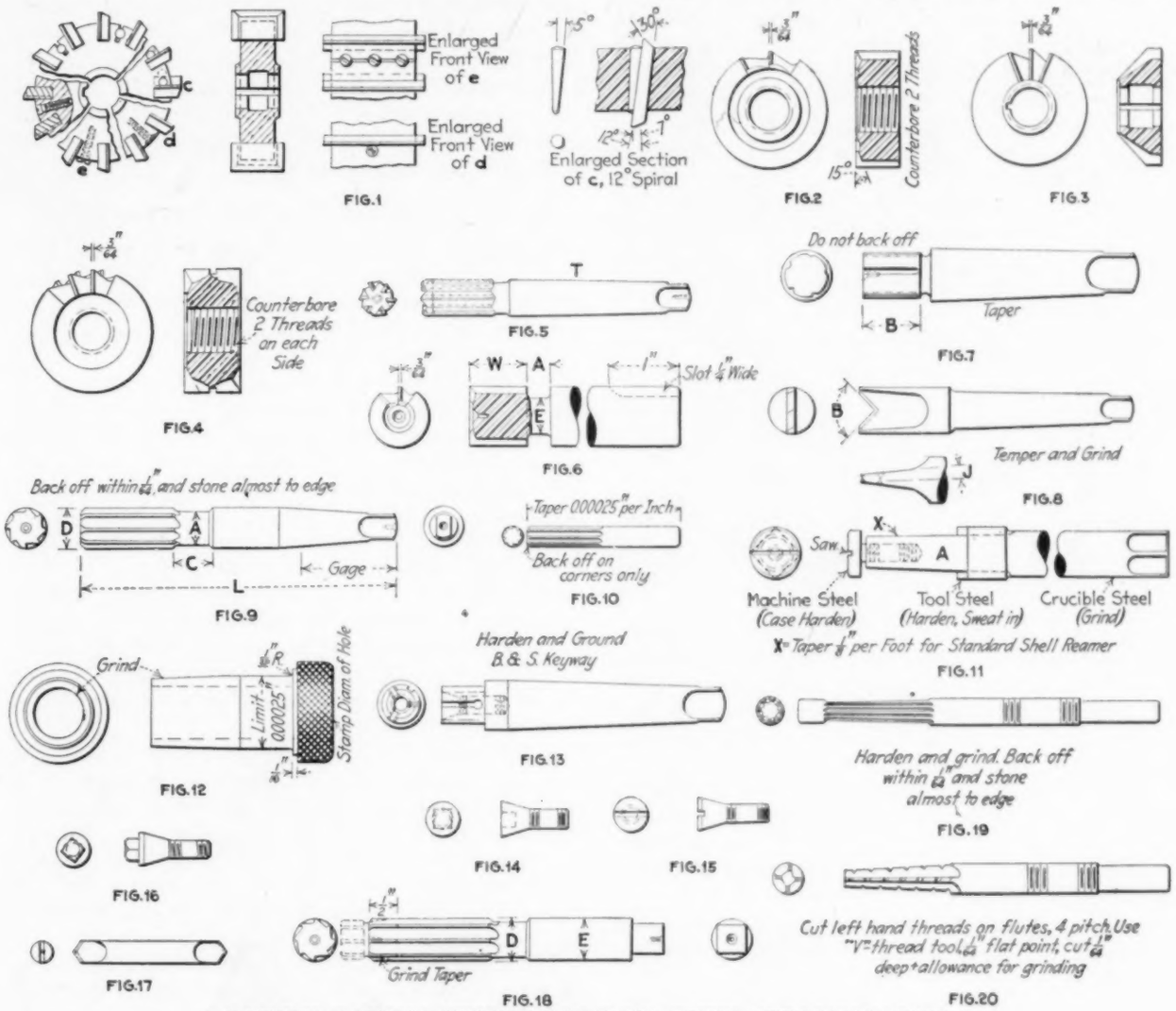
In assembling gangs of milling cutters on arbors it is well to adopt certain standards for the diameter of hole, diameter of hub, and the like. These may run as follows: Diameter of hole, $\frac{7}{8}$ in., 1 in., $1\frac{1}{4}$ in., $1\frac{1}{2}$ in., $1\frac{3}{4}$ in. and 2 in.; diameter of hub, $1\frac{3}{8}$ in., $1\frac{1}{2}$ in., 2 in., $2\frac{1}{4}$ in., $2\frac{1}{2}$ in. and $2\frac{3}{4}$ in.

The width of the land can be from $\frac{3}{64}$ in. up to 6 in.; diameter of cutters, $\frac{1}{16}$ in. for cutters from 6 in. to 7 in. in diameter and $\frac{5}{64}$ in. on all that are over 7 in. in diameter. The backoff of the lands can be from 5 to 7 deg. The thickness of material between the bottom of the gash and the top of the keyway must be at least $\frac{3}{8}$ in.

An old rule that gives good results for milling cutters is: "Ten teeth for the first inch of diameter and four teeth for each additional inch." For roughing cutters the rule is: "Eight teeth for the first inch and two for each additional inch." The Pratt & Whitney formula gives a larger number of teeth. If N equal the number of teeth and D the diameter, the formula is $N = 2\frac{1}{2}\ D + 12$ for face mills and $N = 3.1\ D + 11$ for side mills.

Make all cutters as small in diameter as possible, and have arbor and collar clear all obstacles by at least $\frac{3}{16}$ in.

To cut straight teeth on face mills use an ordinary 60-deg. angular cutter. To cut spiral teeth, use a cutter 12 deg. on one side and 48 deg. on the other. The points


Enlarged Front View of e
Enlarged Front View of d
Enlarged Section of c, 12° Spiral
Counterbore 2 Threads
Counterbore 2 Threads on each Side
Do not back off
Taper
Slot ¼" Wide
Temper and Grind
Back off within ¼" and stone almost to edge
Gage
Taper .00025" per Inch
Back off on corners only
Saw
Machine Steel (Case Harden)
Tool Steel (Harden, Sweat in)
Crucible Steel (Grind)
X = Taper ⅛" per Foot for Standard Shell Reamer
Grind
Limit .00025
Stamp Diam of Hole
Harden and Ground B. & S. Keyway
Harden and grind. Back off within ¼" and stone almost to edge
Grind Taper
Cut left hand threads on flutes, 4 pitch. Use "V" thread tool ¼" flat point, cut ¼" deep + allowance for grinding

A VARIETY OF SMALL CUTTERS AND TOOLS FOUND ESPECIALLY USEFUL

of the cutter teeth should be rounded so as to leave a fillet at the bottom of the gash.

Make all face mills over ¾ in. face, spiral. To bring the thrust against the spindle and prevent loosening of the arbor, for right-hand cutters use left-hand spiral and for left-hand cutters use right-hand spiral. Side mills may be cut spiral when the benefit from the shearing cut overbalances the ill effect of the slight negative rake which is given the teeth.

Solid cutters over 4 in. in width should be made in sections to interlock, because the risk in hardening is too great to permit the use of longer ones.

Make all side and face mills over 6 in. diameter of the inserted-blade type. In Fig. 1 are shown different ways of securing the teeth. Two teeth per inch of diameter is a good average for these large mills. In cutters over 8 in. in diameter the body may be made of cast iron, but below this size and below 2-in. face the body should be of machine steel. The body may be as thin as ¾ in. if the pin binder shown at *C* is used.

Cutters of this style may be made by drilling and reaming the holes and driving the pins in place. The slots are then milled and the pins are already slabbed. It is a simple, cheap and effective way to secure the blades.

The thickness of inserted blades should run from $\frac{5}{16}$ in. to ½ in., according to the size of the cutter. the depth of the chip and the feed which it is expected to take. The depth of the cutter blades should be from 1¼ in. to 1½ in. in the body, and they should project from $\frac{5}{16}$ in. to ⅜ in. above the body and not less than $\frac{3}{16}$ in. on the side. The side and top angles may each be 30 deg.

Butt Mills and Angular Cutters

Threaded butt mills are driven by the thread only and depend for their true running on being forced against the collar of the milling arbor. When possible, it is better to shorten the thread and have a portion of the hole reamed to fit a straight part on the arbor, which adds to the bearing.

A good, strong construction for heavy angular cutters is shown in Fig. 3. The angle is well backed up, and cutters of this type should be used for heavy cuts wherever possible. Grooving cutters which cut on the face only should have the sides slightly concaved, about ½ deg. in extent, something like a saw, to prevent binding or dragging. Instead of concaving the whole side of the cutter, as has been the custom of cutter makers, there should be left a hub flush with the sides of the teeth, thus allowing its use in gangs without danger of springing the arbor.

Double-end butt mills, such as shown in Fig. 4, can often be used to advantage. Their construction and use are obvious.

Stem milling cutters for roughing and high-power end mills should have four teeth for mills which are 1 in. or less in diameter and an additional tooth for each ¼ in. above that. For general work the following table is a guide to the number of teeth on end mills:

Diameter, in.	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{7}{8}$	1
Teeth	6	8	8	8	8	8	10	10	10	10	10
Diameter, in.	1¼	1¼	1½	1½	1½	1½	1¾	2			
Teeth	12	12	12	14	14	14	16	16			

Spiral teeth give the same negative rake on the end of a mill as on the sides of the side mills. The angle of the spiral is usually about 8 or 10 deg., but it may be as high as 20 deg. for cam milling. The angle at which to set the index head when cutting the end teeth of end mills may be found from the following formula, when *N* is the number of teeth to be cut, *V* the included angle of the sides of the fluting cutter and *W* the angle at which to set the index head:

$$Cos\ 2 = \frac{360}{N}\ cotan\ V$$

Center-cut end mills, such as shown in Fig. 5, are often necessary to cut into the surface of work and then feed along, as is done on dies and similar work. The teeth are given clearance only on their inside ends. They are coarse for convenience in making and to enable them to take heavy cuts. Four teeth should be used up to ½-in., six teeth to 1¼-in. and eight teeth for 2-in. diameters. A special type of end mill for cutting cam tracks is shown in Fig. 6. It is made to be held as close to the work as possible. The length of cut *W* is not over ½ in. more than the depth of the track to be cut. The neck *A* is very short, and *E* is just small enough so that the teeth can be milled. On such a cutter it is best to use a positive drive with ¼ in. key.

Teazels and Fish-Tail Cutters

In Fig. 7 is shown what is known as a teazel. It is used to follow the cam cutter just described. It does not cut, but is used as a burnisher to smooth the track which has been cut about $^1/_{1000}$ in. small. The length *B* on the teazel must be left very hard.

The fish-tail cutter shown in Fig. 8 is used in the Pratt & Whitney spline miller, and does the work of an end mill, but more rapidly and at less cost for cutters. The angle *B* is about 90 deg. and *J* is about 3 deg.

A reamer suitable for use through the bushing of the jig is shown in Fig. 9. The space *F* is for a bearing in the bushing. It must be from one-half of a thousandth to a full thousandth inch under size. The other dimensions must of course be made to suit the job for which it is to be used. The flutes are not tapered at all, but must be beveled on the cutting edge as shown. They should be backed off within $^1/_{64}$ in. and stoned almost to the edge. The dimension *D* should be made about $^3/_{10000}$ in. over size, but marked to size.

A cheap and effective dowel-pin reamer is shown in Fig. 10. The teeth are backed off on the corner bevel only and have a taper of only one-quarter of a thousandth on the length *B*, which is given for clearance. There should be two sets of these—one for the part into which the dowel drives and the other set for the part into which it is to press. These reamers can be used in jigs through bushings if desired.

The arbor shown in Fig. 11 and the bushing in Fig. 12 are used together with a shell reamer for align reaming. The hole in the bushing fits the shank of the arbor and the straight portion of the bushing fits the standard reamed hole in the casting. The flutes next to the neck are cut clear through and relieved on the bevel, so that it can be machined with a draw cut. The two holes to be aligned are rough-reamed 0.005 in. under size. The reamer is assembled on the bar and drawn back through one hole, while the shank is guided by the bushing, which is centered in the other hole by its taper part. The operation is then reversed for the other hole, guiding

the shank this time by the bushing which will fit the hole just reamed, and feeding the reamer either way, as is most convenient.

An expansion arbor of the type shown in Fig. 13 for milling cutters may be made to employ any one of the styles of expanding screw shown in Figs. 14, 15 and 16. One that can be adjusted by a square-end wrench is shown in Fig. 14. An adjustment by screwdriver is possible of the one shown in Fig. 15. None of the screws projects beyond the cutter. A screw that can be adjusted by any wrench is shown in Fig. 16, but the projecting square is likely to be in the way very frequently.

When spotting with a twist drill it is frequently found that the drill goes too deep. With the special spotting drill shown in Fig. 17 there is no danger of this occurring, as it can cut only on the point. It has no flutes, which is an advantage in using a drill of this kind through a bushing. It is often used through a slip bushing and followed by a twist drill without a bushing, and then by a reamer running in the same slip bushing as the spotting drill.

Guide Used with Standard Reamers in Jigs

No one thing causes more loss of time than the lack of the proper reamers for the particular job in hand. The commercial hand reamer may be adapted to tool work as shown in Fig. 18, where the dotted line at *M* shows a guide. This takes the place of the usual taper given the end of hand reamers. In length the guide should be from one to one and a half times the diameter and from 0.005 to 0.010 in. smaller than standard size, up to reamers of 1 in. in diameter, and from 0.012 to 0.015 in. smaller for larger diameters. The flutes run out to the guide as shown; but they are not backed off. There should be a short taper from the groove between the guide and the reamer which allows for grinding. The shanks of such reamers should be from 0.001 to 0.001½ under size, and the corners of the square for the wrench should be turned down even smaller, so that possible burrs from the wrench will not spoil the hole if the reamer is passed clear through the work. The fluting should be done with the cutters set a trifle ahead of the center of the reamer, so as to give a slight negative rake. A slight staggering of the flutes, not more than 2 deg. either way from an even division, is helpful in reducing the tendency to chatter. Sometimes the pilots for hand reamers are threaded—18, 14 or 32 threads per in., with a sharp *V* thread to help feed the reamer into the work. Care should be taken that the pilot is enough below size so as to make sure that these threads are cleaned out by the reamer.

Proportions of Small Finishing Reamers

The lands of the cutting edges should be $\frac{1}{32}$ in. wide for small reamers, $\frac{1}{16}$ in. for reamers 1 in. in diameter and $\frac{3}{32}$ in. for those still larger. Flat relief is suitable for roughing reamers, but a rounded or eccentric relief is preferable for finishing reamers, as it causes them to cut more smoothly. A guide to the number of flutes in reamers is shown in the following table:

Diameter, in.....	¼	¼ to ½	⅝ to 1¼	1¼ to 1½	1½ to 2¼	2¼ to 3	4
Number of flutes.	4	6	8	10	12	14	16

This table is practically standard for all styles of reamers.

Roughing and finishing reamers for use in jigs are shown in Figs. 19 and 20. With reamers made with curved shanks for stop collars and the guide for the finishing reamer as shown, it is possible both to rough-ream and finish-ream work in jigs for taper pins. On account of the extreme accuracy required in making the tools, it is usually more costly to do so than to rough-ream in the jig and finish-ream in the assembling. The stop collars may be split collars or may be two solid collars used as check nuts. The reamers shown in Figs. 19 and 20 are made in two parts and sweated together, so that when the reamer part breaks the rest is not lost.

Four-Spindle Centering and Drilling Machine

The machine here shown was made to center simultaneously both ends of detonator gaine bodies, and then by shifting the position of the heads, to drill a hole in each end at the same time. Fig. 1 shows the machine in centering position, and Fig. 2 shows it in drilling position. The construction of the machine is such that it may readily be adapted to other work of various diameters and lengths. It may also be made with two opposing heads instead of four, where the requirements call

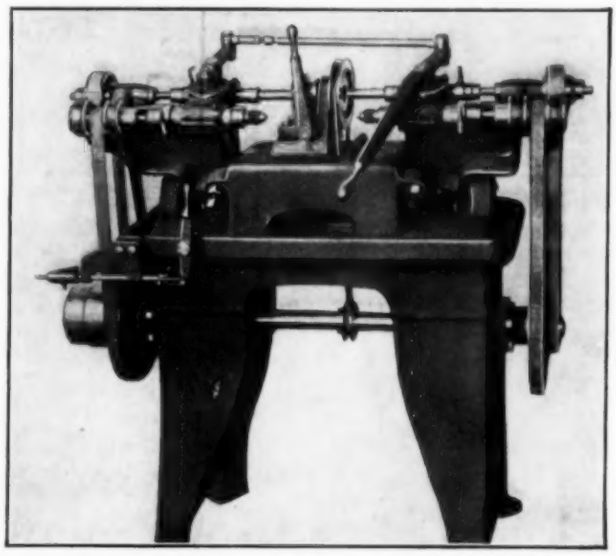


FIG. 1. SPINDLES IN CENTERING POSITION

for a machine of that type. The machine is entirely self-contained, as it carries a tight and a loose pulley and may be belted direct from the drive shaft, or it may be motor driven if desired. The single lever control makes it possible to turn out high-speed accurate work at a very rapid rate.

The cast-iron heads carrying the spindles are keyed to a shaft running lengthwise of the bed, so that they move in unison. Adjustable stops on each side serve to register the spindles central with the work when the heads are swung over against them. Each spindle is carried in a sleeve with a rack cut in it, similar to that of an ordinary drilling machine. A gear meshing with these racks is set down between the spindles of each head. The gear in the right-hand head is connected direct to the operating lever; but the one at the left is connected by means of a supplementary pinion and a segment, in order to cause the spindles to move in a direction opposite to the opposing ones as the yoke-connected levers are moved by the hand

lever. It will be readily seen that as one pair of opposing spindles moves in, the other pair moves out, and vice versa. It will also be seen that the same lever that feeds the spindles in or out is used to swing the heads over against the stops, forward or back.

ARRANGEMENT AND CONTROL OF THE DRILLING SPINDLES

The drilling spindles are made of a special high-grade steel, ground and carefully fitted. These spindles run in annular bearings inside the steel sleeves. Each is taper

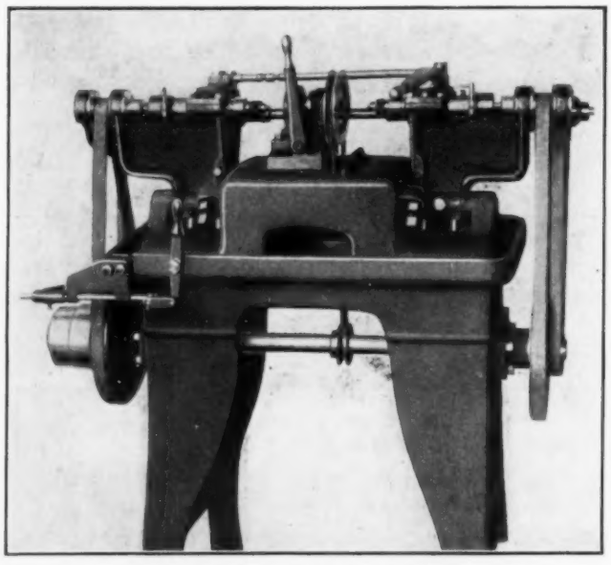


FIG. 2. SPINDLES READY FOR DRILLING

bored to hold a No. 1 drill chuck. The spindle pulleys are of aluminum and are mounted in two annular bearings each. The spindles are graduated and provided with adjustable stop collars. The direction of rotation makes it necessary to use right- and left-hand drills in the respective spindles. Each spindle has a longitudinal travel of 2 in.; the maximum distance between the chucks is 8¼ in.; the distance from the center of the spindles to the bed is 4¼ in., and they run at a maximum speed of 10,000 r.p.m.

The centering spindles are of special steel and run in bronze bearings. Ball thrust bearings are provided at

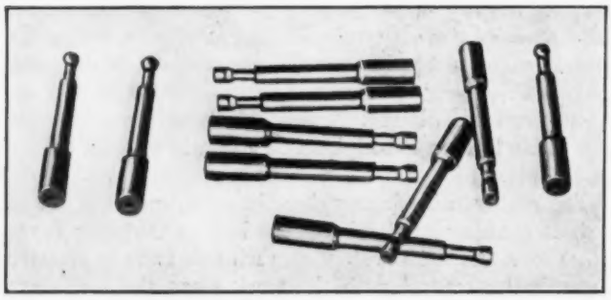


FIG. 3. PINS CENTERED AND DRILLED IN THE MACHINE

front and rear. They are bored for No. 1 Morse taper shanks. The travel is the same as that of the drilling spindles, but the maximum speed is 1,500 r.p.m.

The revolving work chuck is carried on a special bracket mounted between the spindles, as shown. The chuck is of the split-collet type operated by means of a lever, shown in front. By using this type of chuck, work may be inserted or removed without stopping. The chuck is driven by means of a round belt from a grooved pulley on the main-drive shaft underneath the bed. This chuck has a maximum speed of 750 r.p.m.

A number of the gaine bodies drilled in this machine are shown in Fig. 3. The tapered shoulder on one end serves to locate the piece in the chuck as the small end is gripped in the collet operated by means of the lever. A hole 1⅛ in. deep is drilled in each end with a No. 30 drill.

All bearings in this machine are provided with oil cups. The oil pan is cast integral with the bed. The shaft underneath the bed runs in annular bearings at a maximum speed of 1,500 r.p.m. The machine stands 42 in. from the floor to the center of the spindles. It occupies a floor space of 24x48 in., weighs approximately 550 lb. and is made by W. P. Kirk, 336 West Fourth St., Cincinnati, Ohio.

Present Conditions in Russia

The economic conditions of Russia have been considerably disturbed, but not shattered, during the present European war as a direct consequence of preventing export of produce and raw materials. Only two ports are now open to Russia, namely, Vladivostok on the Pacific and Archangel on the White Sea. The latter is closed, more or less, during the four winter months, although powerful ice-beakers are expected to operate in an effort to keep the channel open as late as possible and to open it earlier in the spring than usual.

There remains in northern Finland the railway to Sweden and Norway, giving traffic connection with the allies as well as with friendly and neutral countries. This is extensively used, so that the domestic railways and interior waterways are not able to clear the wharves, docks and storage places from congestion and from the constantly arriving freight, principally of war material.

The transportation facilities have proved absolutely inadequate, and great hardship is suffered in many places from the lack of wood, coal and oil for fuel and power. Prices of food and the prime necessities of life are high, even in such places as are fairly well provided with good roads, railway and water connections. The Central Government is doing its best to ameliorate conditions, but as every energy is directed toward active prosecution of the war itself, it is practically impossible to carry out satisfactorily these humanitarian purposes.

Credit is needed by the Russian merchant importing American goods, but not to the extent in the value of the merchandise nor on such long terms as he was accustomed to obtain from both Austria and Germany.

Today Russia is absolutely offering to Americans enormous concessions of varying character in European Russia, Siberia, Asiatic Russia, the Trans-Caspia, Turkestan and the Caucasus, upon the most liberal terms. These concessions include railways, both steam and electric, urban, interurban, or practically transcontinental, bridges, canals and locks, transportation on interior waterways, utilization of the Empire's enormous water-power, mines, dredging operations—both harbor and internal waterways, mines, industrial, manufacturing, or public-service plants; and virtually everything in any way allied to economic development or improvement.—W. Aisenman in *American Industries* for December.

Pressed Steel in Manufacture of Electric Motors

By C. W. Starker*

SYNOPSIS—A description of the hot- and cold-working processes used in making the pressed-steel parts of electric motors. These processes include blanking, rolling, drop forging, press forging and riveting. The parts are frame rings, end rings, rails, feet, bedplates, end brackets, brush-holders and bearing shells.

For several years past in practically every industry there has been a marked tendency to employ sheet steel punched or pressed to shape where formerly cast material was used. In fact we may recognize in this tendency one of those natural steps of advancement in the art of using materials that consist in going from a material easy to obtain and easy to work, but of inferior grade, to one requiring a greater degree of development for its utilization. For examples we need not go very far. Buildings and bridges formerly made of wood progressed to stone and then to structural steel. Many household articles are now drop forged or pressed from steel plate after having gone through the successive steps of development from wood to cast iron, from cast iron to malleable iron and finally to steel. Things which at first glance do not seem to lend themselves readily to pressed-steel construction, like a freight car or a bathtub, are now manufactured under the press.

In all these cases the new method has given a more durable product, more accurate duplicates and if made in sufficient quantities, a cheaper though better output. It is true that the more perfect the product the higher will be the demand for quality in the machine tools, materials and human skill behind it. While woodwork requires only simple tools, and castings require furnaces and molding machines, steel plate and wire require rolling mills for their production, and steam hammers, forging presses and dies to work them to the desired shape.

I do not need to call attention to the extensive application of pressed steel in the automobile industry, but the application of this material in the manufacture of electric motors has thus far not been described in detail in a technical journal, although it is now more than five years since a pressed-steel motor was first worked out by the engineers of the Westinghouse Electric and Manufacturing Co. At that time this design was quite a departure in motor manufacture and attracted considerable

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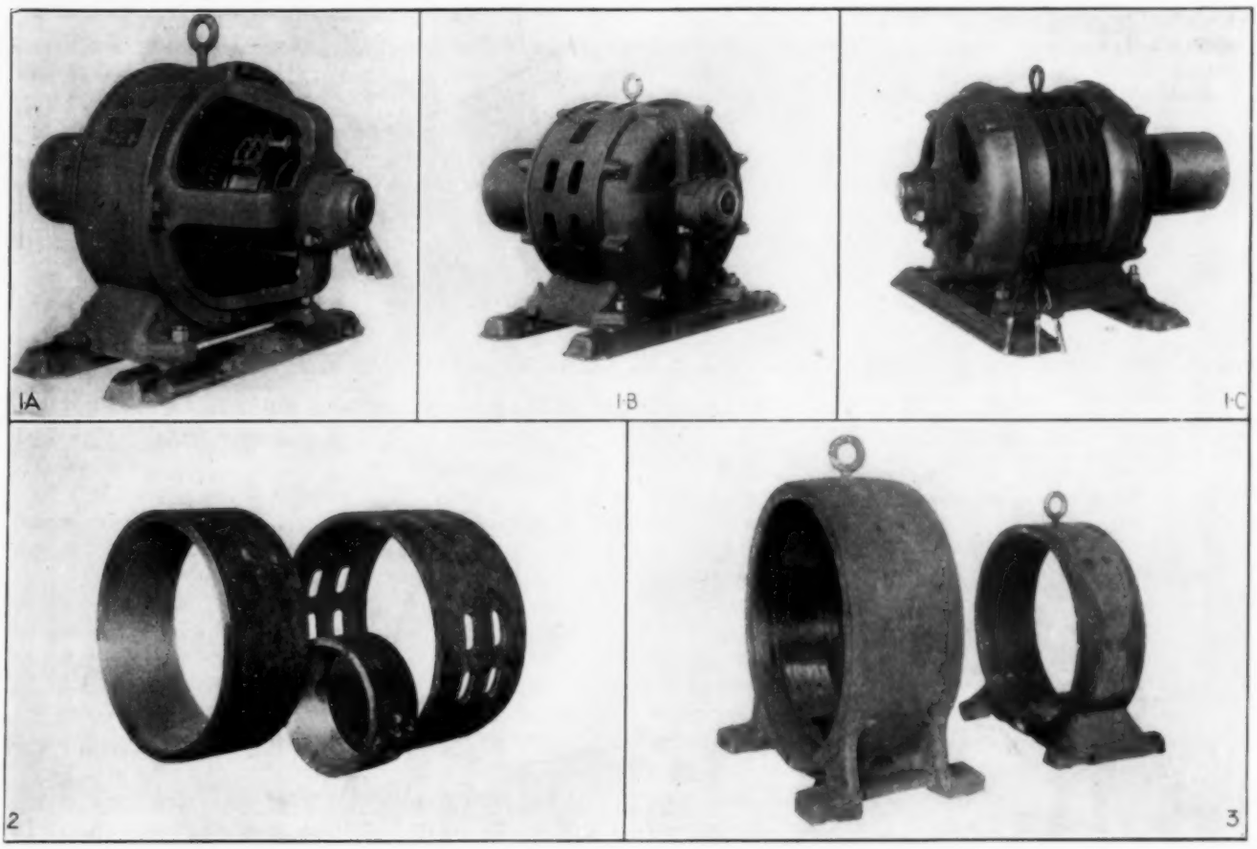


FIGS. 1-A TO 3. PRESSED-STEEL MOTORS AND ROLLED-STEEL FRAME RINGS

Fig. 1-A—100-hp. motor with rolled-steel frame and pressed-steel feet and slide rails. Fig. 1-B—50-hp. motor with feet and slide rails and pressed-steel, rolled-steel frame. Fig. 1-C—10-hp. motor with pressed-steel frame, feet, slide rails and bearing brackets. Fig. 2—Complete pressed-steel electric motor rings. Fig. 3—Comparison of cast-iron and rolled-steel motor frames of same capacity

attention. Since then perhaps a hundred thousand such motors, both for alternating current and direct current, have been put in service and have proved successful even under trying conditions, such as steel-mill work. In this article a short description of the construction and manufacturing processes used in building these motors will be given.

A Few Types of Pressed-Steel Electric Motors

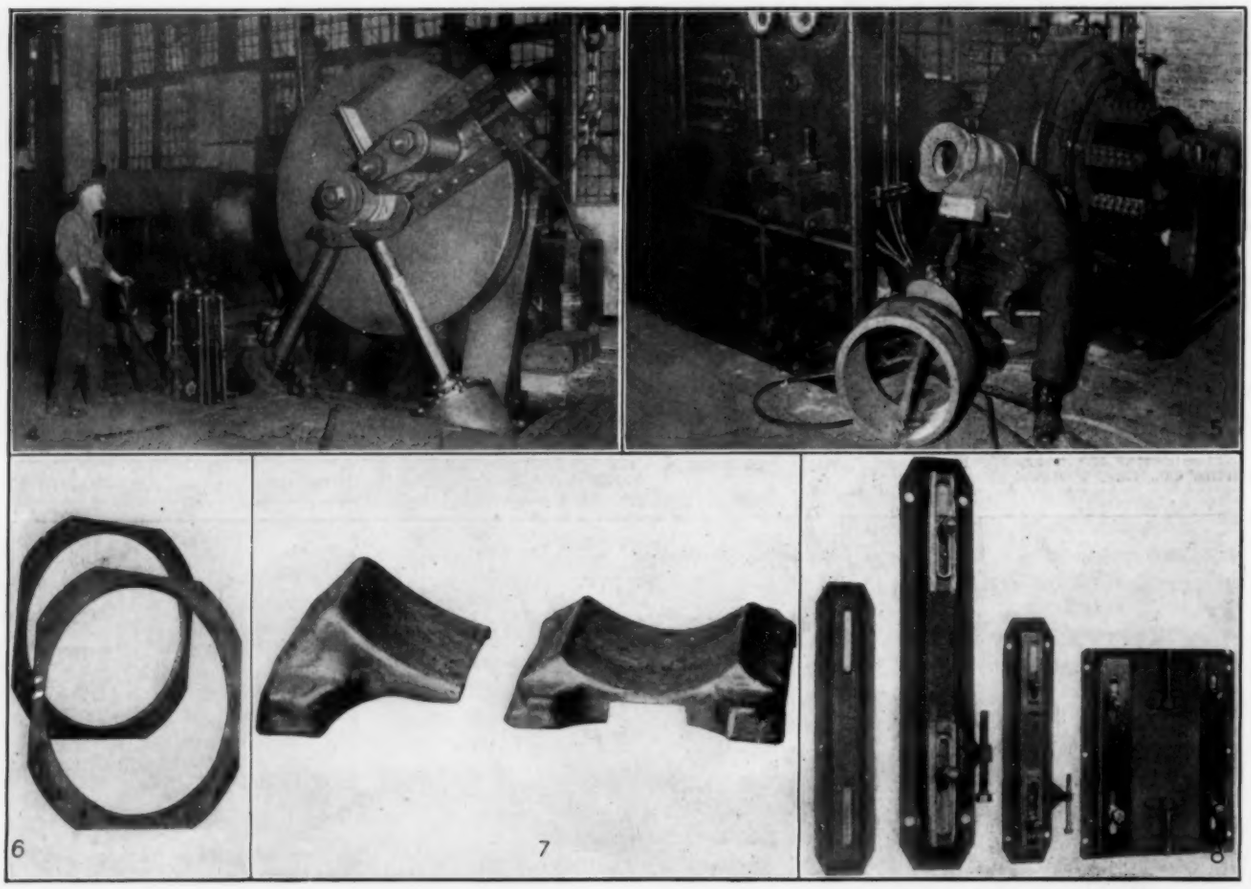
Motors of this type are shown in their finished form in Fig. 1. Their principal mechanical parts of steel design consist of a frame or yoke with feet, brackets carrying the bearings, slide rails, or bedplate, for adjusting the belt tension, and minor parts as end plates, brush-holders, bearings, etc. All of these parts are now made under the press from steel plate, thus giving a better and more economical product in large-scale manufacture.

The frame rings, which in the case of a direct-current motor carry the magnetic flux and in the case of an alternating-current motor serve as a casing for the primary laminations, are in both cases made from a hot-rolled steel slab. Such rings are shown in three different sizes in Fig. 2. For direct-current motors it has long been recognized that cast iron makes a heavy and bulky yoke, as a large cross-section is required for the magnetic flux. Cast steel is better, but a good grade is expensive, and as with every steel casting, there is the danger of blow-holes. These motors now have a yoke made from hot-rolled steel plate, which has the same high magnetic characteristics as the punchings used in the armature and is free from structural imperfections. The cross-section may therefore be small and the yoke lighter in weight. The relative size of a finished cast-iron frame compared with a rolled-steel frame is shown in Fig. 3, which compares a cast-iron and a rolled-steel frame for a motor of the same capacity.

These frame rings are rolled from straight slabs on a machine especially designed for this purpose, shown in Fig. 4. This machine is driven by an electric motor, and the rams are operated by water. The manufacturing process is substantially as follows: The slabs from which the rings are to be rolled are first sheared to correct length to make a perfect joint when formed to a circle. Next they are heated in a furnace located near the rolling machine. The heated slabs are then formed to the desired diameter by rolling. This process takes but a short time in the hands of a well-trained crew, although the rings are rolled accurately to gage. On the rolling machine, rings can be rolled to any desired diameter within the machine's capacity by using different mandrels.

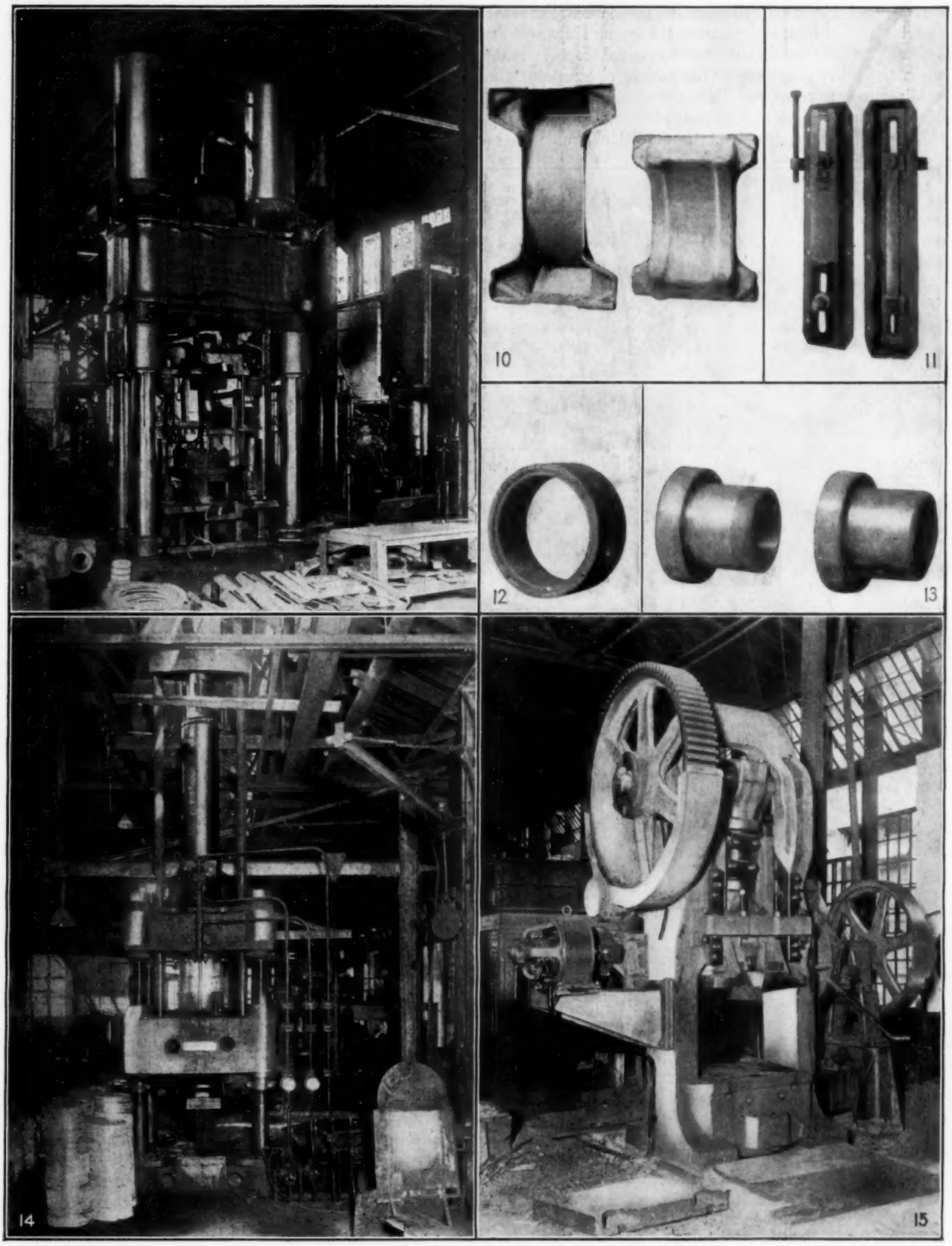
At the present time this process is used for the ring frames of motors up to 200 hp., requiring rings up to 3 ft. inside diameter, with a maximum thickness of up to 2 in. and a maximum width of about 17 in.

After rolling, the frame rings are welded at the joint, whenever this is required for magnetic reasons. This weld-



FIGS. 4 TO 8. FORMING FRAME RINGS AND DETAILS OF FEET AND RAILS

Fig. 4—Special machine for rolling steel motor frames. Fig. 5—Welding joint in rolled-steel motor frame rings. Fig. 6—Motor end plates made by bending steel bar on edge. Fig. 7—Drop-forged-steel electric motor feet. Fig. 8—Pressed-steel slide rails and bed plate for small motors



FIGS. 9 TO 15. FORGING PRESSES AND SOME OF THE PARTS PRODUCED

Fig. 9—1,000-ton steam-hydraulic forging press. Fig. 10—Pressed-steel feet for large motor. Fig. 11—Pressed-steel slide rails for large motor. Fig. 12—Squirted frame ring for small motor. Fig. 13—Squirted commutator bushing—rough and finished. Fig. 14—540-ton double-acting forging press. Fig. 15—Large motor-operated eccentric forging press

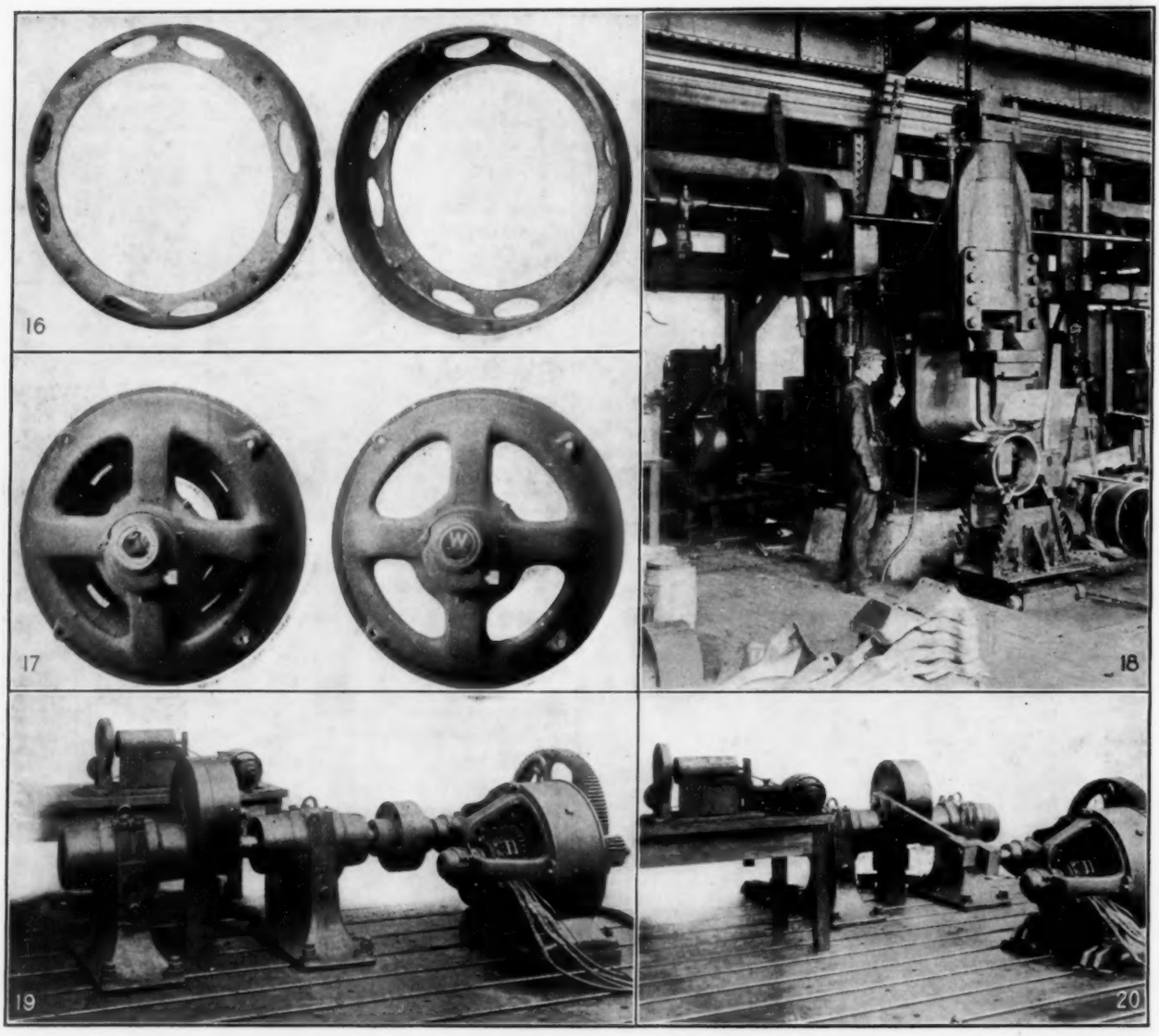
ing is done by the electric-arc welding process, Bernardos' method. A view of the welding plant is shown in Fig. 5. This view shows the converter set in the rear and the switchboard. In actual operation the frame rings rest on a steel plate. One terminal is connected to this plate while the other one leads to the carbon electrode of the welding tool manipulated by the operator. The arc is drawn from the carbon to the motor frame, rapidly raising the metal to the melting point. Additional material to fill the joint is supplied, if needed, by a soft-iron rod held in the arc.

For purposes of ventilation it is sometimes desirable to have holes in motor frames. The frame ring, shown at the right in Fig. 2, has 16 such ventilating holes. They are punched cold before bending, in any thickness of plate that is used at the present time.

It should be understood that this rolling process is not intended to change either the thickness or the length of the material, but is only a bending operation.

Another product of this rolling machine is the set of end plates, shown in Fig. 6, which are made from a hot-rolled steel bar and used at the ends of the primary laminations of alternating-current motors. They are manufactured in large quantities by a process quite similar to that described in connection with the frame rings. Being made of a material superior in structure to any cast material, they are comparatively thin. This gives them the advantage of taking up less space in the motor, thereby reducing the amount of inactive copper in the windings and the danger from short-circuits between the end plates and the winding. These steel end plates also are unbreakable. Breakage is a serious factor in the manufacture of cast-iron parts, and an item of expense which frequently is under-estimated. If a break does occur, it usually happens after the shrinkage strains in the casting are released by removing the hard outer crust of the casting, that is, after the casting is machined and a considerable amount of labor has been spent upon it.

Two different designs of pressed-steel motor feet used in the smaller motors are shown in Fig. 7. They are made either in halves or in one piece. Both kinds are shown. A high-grade quality of steel plate is used, ¼ to ½ in.



FIGS. 16 TO 20. STEEL END BRACKETS AND TESTS OF THE MOTOR

Fig. 16—A pressed-steel motor end ring. Fig. 17—Pressed-steel end brackets for electric motors. Fig. 18—100-ton hydraulic riveting press. Fig. 19—Eccentric load test on 15-hp. pressed-steel motor. Fig. 20—Oscillator test on 15-hp. pressed-steel motor

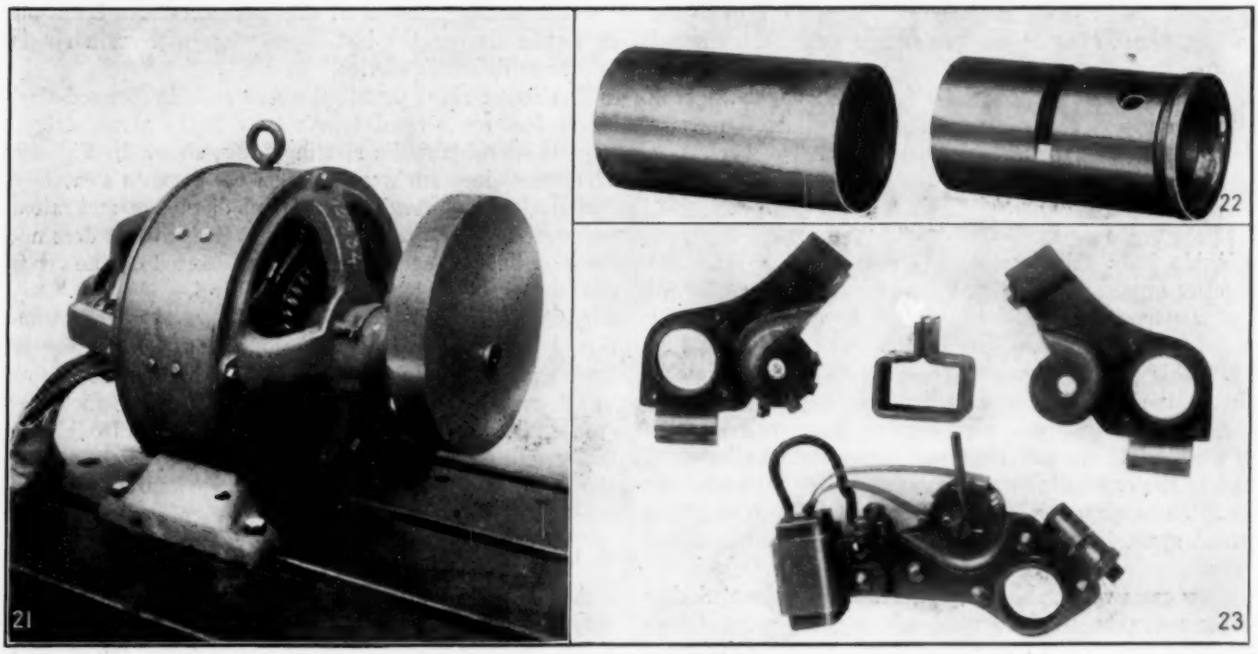
thick, depending upon the size of the motor. This plate comes from the mill in large sheets, which are cut into squares of the proper size on a 110-in. motor-driven shear. For each different piece to be pressed or forged, the developed shape necessary to produce the desired final result is determined by continued experiments, and the blanking dies are then made for punching out the blanks. These blanks are heated and forced to the proper shape, as shown in Fig. 7, by one or two blows of a 2,000-lb. drop hammer. With a given blanking and forging die every foot will of course be a duplicate of every other. All fitting, trimming and removing of unnecessary stock are therefore avoided, a point which greatly aids in rapid manufacture.

Drop-Forging Slide Rails for Electric Motors

Another product of this hammer is shown in Fig. 8—pressed-steel slide rails used under the motors to adjust the belt tension. To the left the rough forging is shown as it comes from the forging department, then one of the medium-sized and one of the smaller-sized rails in finished form, and finally one of the smaller pressed-steel bedplates made in the same way as the rails and similar to the pressed-steel foot described above. All of these rails are made from heavy steel plate amply strong for ceiling suspension of the motor and with ample floor area for use on a soft foundation. The pressed-steel rail or bedplate, compared with cast iron, has among others the advantage of being stronger and unbreakable for a lower weight. In castings a crack occasionally occurs which is hard to detect and may pass by the inspector. It is possible that the faulty material is not discovered even by careful inspection until some accident has occurred, particularly with a motor suspended from the ceiling.

The drop-forging method described above has in the last few years found a serious rival in the hydraulic press. The drop hammer, though a handy and simple machine suitable for a great variety of forgings, has its limitations, especially as to the size of forging and the thickness of material that can be worked. The hydraulic press with its slow and steady pressure is preferable to the hammer for some kinds of pieces. While hammer blows affect practically only the surface of the forging, the hydraulic pressure penetrates to the core, even of thick forgings, resulting in a denser and more homogeneous material in the finished forging. Quicker and better work is possible for the reason that one stroke of the press produces the same results regarding reduction of section as five or six blows of the steam hammer; and under the press the hot steel more readily fills the impressions in the die. Absence of shocks, therefore less danger of breaking piston rods or dies, the possibility of a lighter foundation and less expensive dies, easier work for the men and lower power consumption are also points in favor of the press.

A 1,000-ton, high-speed steam-hydraulic forging press installed for the manufacture of large pressed-steel parts for electric motors is shown in Fig. 9. This press is of the four-column type and designed on the Davy principle. The installation consists of the press proper, with the main cylinder in the center, two steam lifting cylinders on top, the steam-hydraulic intensifier with the controlling gear, and finally the storage tank, which appears at the left. This tank is known as the prefiller and serves as a receptacle for the water, which is used repeatedly. Sufficient air pressure is supplied at the top of the tank to force the water into the cylinder. A steam pressure of about 150 lb. per sq.in. is used in the cylinder of the intensifier. By the action of this cylinder a hydraulic pressure of 5,500 lb. per sq.in. is produced behind the plunger. The actual forging work is done by the main cylinder, which produces with the hydraulic pressure mentioned a total pressure of 2,000,000 lb., with a possible increase to 2,400,000 lb. The lifting cylinders referred to serve



FIGS. 21 TO 23. ANOTHER TESTING ARRANGEMENT AND SMALL STEEL PARTS

Fig. 21—Eccentric load test on 30-hp. pressed-steel electric motor. Fig. 22—Pressed brush-holder and parts—may be either brass or steel. Fig. 23—Babbitt-lined steel shell bearing made of tubing

the purpose of raising the heavy cast-steel press head that holds the upper part of the die. The most interesting part of this press is the control, which is effected by a single lever for all movements, whether actuated by the steam or by the hydraulic pressure. The press head follows the movement of this lever, both as to speed and length of stroke, so that high speed and short strokes may be obtained, or as slow speeds as may be required in a particular case. Up to 150 strokes per minute may be made with this press, so that the output in forging and punching is limited only by the rapidity with which the work can be fed into the machine.

Two different sizes of large pressed-steel double feet for motors are shown in Fig. 10. They are hot pressed from steel plate ½ in. thick and in floor dimensions of about 2½x4 ft. Those familiar with this class of work will appreciate the difficulties that had to be overcome before producing a deep and intricate forging of this kind. The forming is done without any hammer blows or noise, by moving a single lever.

A large-sized pressed-steel rail made on this press, $\frac{7}{16}$ to ½ in. in thickness and in lengths up to 6 ft., is shown in Fig. 11. Pressed-steel bedplates, of the design shown in Fig. 8, are also made on this press and can be forged up to 6 ft. in length. Before pressing, all of these parts are blanked out as described above. This blanking can also be done on this press, although of course it may be done on other equipment of smaller size.

Piercing, or Squirting, Process of Forging Electric-Motor Parts

Aside from this forming of the plate, the press has another important function in the manufacture of forged motor parts by the piercing, or squirting, process. A small frame ring 8 to 12 in. in diameter is shown in Fig. 12. This piece is squirted from a solid block of steel; that is, the steel block is heated and placed in a cylindrical die, then by exerting a very high pressure in the center of the block the material is forced up uniformly all around and to the exact diameters determined by the size of the die. These rings are squirted about a foot high and then sawed apart to give the proper width of the individual ring.

New cases where this press and especially the squirting process can be used to good advantage present themselves frequently. A commutator bush in its rough-forged and in its finished form is shown in Fig. 13. It is made by the same method as the small frame ring just described, by piercing a solid steel block. This process has opened up entire new fields of manufacture, for not only is it possible to obtain sound and dense material superior to the steel casting heretofore used for parts which are required to stand severe strains, but this new process is also in most cases more economical. In quantity production it would tax the capacity of the best molding machine operated by the fastest molder to compete with the press that forms a large commutator bush with a single squeeze by the movement of a single lever.

Further equipment for the manufacture of pressed-steel motors is shown in Figs. 14 and 15. The one shows a 540-ton double-acting hydraulic press, the other a slightly smaller motor-operated eccentric press. Both may be used for making such parts as pressed-steel end shields, shown in Fig. 16, which are used on the smaller sizes of alternating-current motors—the so-called frameless type—and serve as a means for securing together the primary laminations and for protecting the winding. These end shields are made from ¼- to ⅜-in. thick hot-rolled steel plate in varying diameters and different widths of flange. After forming, the center and the vent holes are punched out in a separate operation.

These presses are also used in the manufacture of pressed-steel bearing brackets, an example of which is shown in Fig. 17. This is an interesting piece of pressed-steel work and perhaps as fine an example as can be found of how far it is possible for pressed steel to take the place of complicated castings. Note particularly the doubled-up rim of this bracket, which gives it great rigidity, and also the flanged part around the housing. These housings are simple castings inserted into the bracket under the press while the bracket is hot, and in such a way that the housing makes its own hole and the flange shrinks to the housing. The housing has a rim on the inside that presses against the inner side of the bracket forging. Numerous tests were made at the time this bracket was first designed to show how reliable the shrink fit is, in resisting both a pushing and a turning force. Some hundred thousand of these brackets have been put in service during the last three years without a single failure or defect in service.

The frame rings described above and the pressed-steel motor feet are riveted together by heavy rivets driven on a 100-ton hydraulic riveting press, shown in Fig. 18. The frame rings are brought under the press on a carriage that is adjustable for different frame diameters, and raised or lowered by compressed air so that the pressure does not come on the carriage. The pressure exerted on the rivets can be varied to suit the size of the rivet.

Numerous running tests of the severest nature, continued for over two years previous to the marketing of these pressed-steel motors, and many thousands of motors in successful daily service have established the fact that even excessive stresses are safely transmitted through the frame and foot without any deteriorating effect on the riveted joints made by this continuous-pressure riveter.

Endurance Tests on Pressed-Steel Motor Frames, Bases and Other Parts

A short description of some of these endurance tests may be of interest to those of the readers who use riveted joints in their work. Fig. 19 shows a test motor back geared to a heavy eccentric weight and reversing every 12 sec. This test was continued for a year and a half, day and night, and showed no effects on the rivets or any other part of the motor. In Fig. 20 the eccentric weight is mounted directly on the motor shaft, tending to produce a strong rocking motion and severe strains on the bearings and frame construction. The oscillator test, Fig. 21, is still more severe, but also failed to have any effect on the motor aside from normal wear of brushes and commutator. This test is arranged so that the eccentric weight does not make a complete revolution but oscillates both ways from the vertical center line. During the several months' run most of the auxiliary parts broke in turn; the driving rods, countershaft and their bearings had to be replaced, but no parts of the pressed-steel motor. These tests and other modifications such as chain-driven eccentric weights, etc., were carried on for years on both the alternating-current and the direct-current motor of pressed-steel construction.

As related in a way to the pressed-steel work used on these motors, which forms the subject of this article, the pressed-steel brush-holder, shown in Fig. 22, and the steel shell bearing, Fig. 23, may be referred to in a few words. The former is pressed from heavy cold-rolled sheet steel or sheet brass, the halves and the brush-holder boxes being riveted or spot-welded together. The bearing shown is one of the simplest types of the solid oil-ring type. It is obtained by drawing steel tubing through a die on the draw bench in 8- or 10-ft. lengths until the proper diameter and wall thickness are obtained. The shell is then tinned on the inside, lined with babbitt and the necessary machining and grinding operations performed. A bearing of this type is both light and rigid, and has met with remarkable success in operation since 1907.

The success of this pressed-steel idea as applied to industrial motors of all classes has been so complete that the design of a pressed-steel motor for street-car service, admittedly one of the most trying applications, was undertaken about two years ago.

Steel Car Straightener and Railroad-Shop Kinks

EDITORIAL CORRESPONDENCE

The growing use of steel cars has necessitated many changes in railway shops, as their repair is an entirely different proposition from handling wooden cars. Whenever a steel car gets into a wreck, the plates buckle instead of splintering, as is the case with wood, and instead of replacing broken sides and ends it is often possible to straighten them so as to be perfectly serviceable without renewing any of the sheets.

Straightening, however, is not an easy job, unless considerable pressure can be applied. This in the average shop means special blocking of various kinds, all of which consumes considerable time. After experiencing all these difficulties, Mr. Paxton, superintendent of motive power of the El Paso & Southwestern Ry., decided to build a permanent straightening frame at El Paso, Tex., as shown in Fig. 1. The machine consists of six frames erected over one of the yard tracks, tied together at the upper corners and braced across the top, and the pressure applying devices. There are of course suitable foundations under the columns on each side. Now when a damaged car comes in for repairs, it is run inside this frame, and pressure can be applied on both sides at almost any point desired. Any intermediate points can be covered by merely moving the car back or forth on the track. This, in other words, is a permanent "old man."

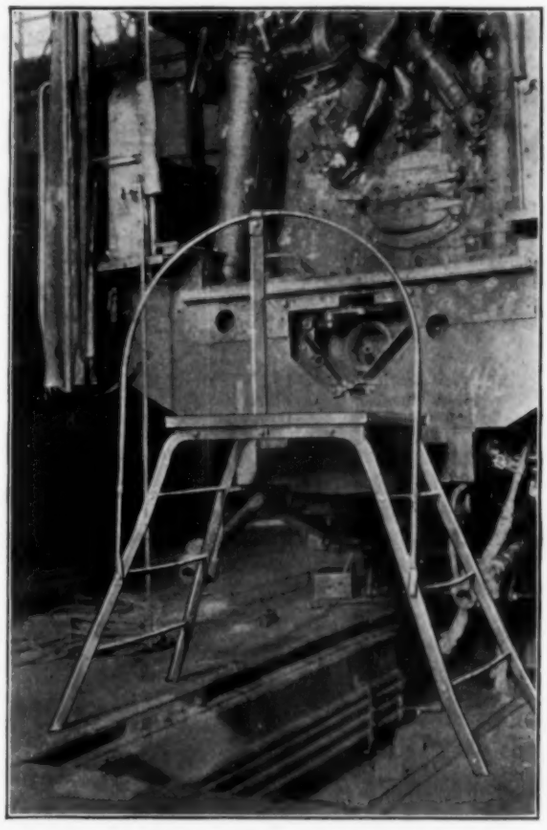


FIG. 3. SAFETY LADDER FOR ERECTION SHOP

Some of the straightening screws can be seen projecting from the columns, which are adjustable for height to any desired point. In addition to the screws, hydraulic jacks of any power required can be placed between the uprights and the car sides, so as to secure all the pressure that may be necessary.

Another interesting development of these shops is the method of utilizing old boiler flues for making pilots, or cowcatchers. One is shown in Fig. 2. It is all ready to go in place on a locomotive. These pilots are quite easily made by cutting the old tubes to the proper length, flat-

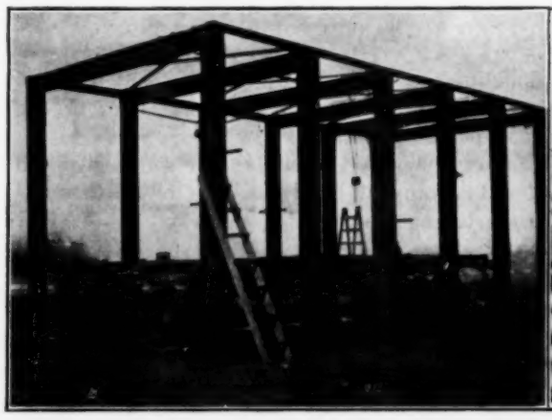


FIG. 1. STRAIGHTENING DAMAGED STEEL CARS

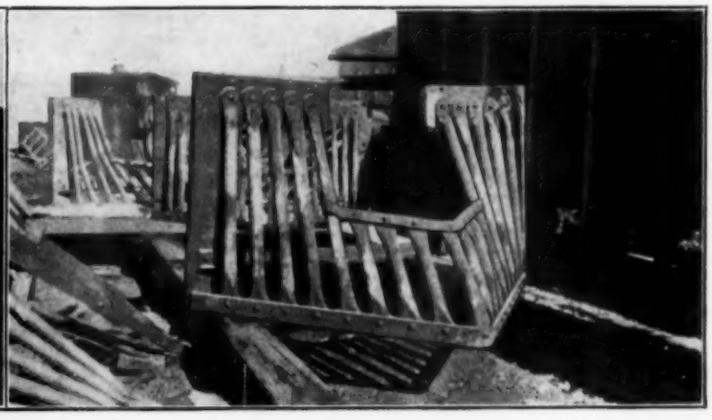


FIG. 2. PILOTS OF DISCARDED BOILER FLUES

tening the ends and riveting them up, as shown. They have proved quite satisfactory in actual service.

Fig. 3 shows a very neat form of safety ladder for climbing up into the cabs of locomotives in the erecting shop. The ladders are made up of metal, with the exception of the platform at the top, and are very easily handled. As can be seen, they straddle the track over

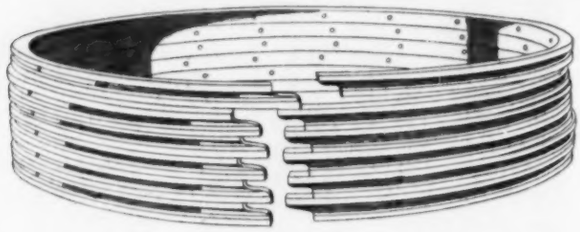


FIG. 4. GROOVED PISTON RINGS

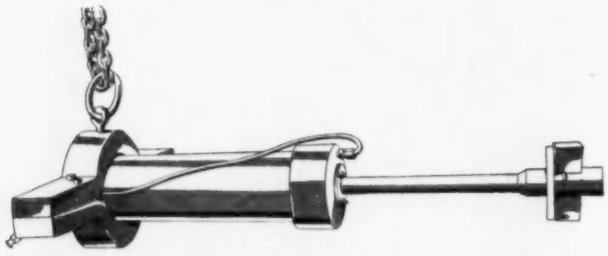


FIG. 5. HYDRAULIC BUSHING EXTRACTOR

the pit and fit up close to the locomotive cabs. They are provided with a safety handrail and are a vast improvement over many of the makeshifts which we too often find in small railway shops.

The type of piston ring used is seen in Fig. 4, which shows a pile of six rings ready to be put into their pistons. The type of joint will be noted, as well as the facts that they have half-round grooves in the center and that small holes are drilled from the bottom of these grooves to the inside of the ring. This is done both to equalize steam pressure and assist in better lubrication.

A portable hydraulic press for pulling cylinder and piston-valve bushings is shown in Fig. 5. It requires no explanation, being suspended from the crane in any desired position.

Feed Mechanism for Boring Bar

By M. R. Bowerman and Thornton Hayes

Last summer it was found necessary to bore out the cylinder of the Corliss engine in the power plant of the Kansas State Agricultural College. The cylinder is 16x48 in. in size. A portable boring bar of the traveling-head type was obtained from Kansas City. The feed mechanism, however, was missing, and it was necessary to improvise a method for obtaining a uniform, slow feed. The feed screw for actuating the boring head lay in a groove in the bar. The feed mechanism shown in the illustration was schemed out. Arrows show the direction of turning.

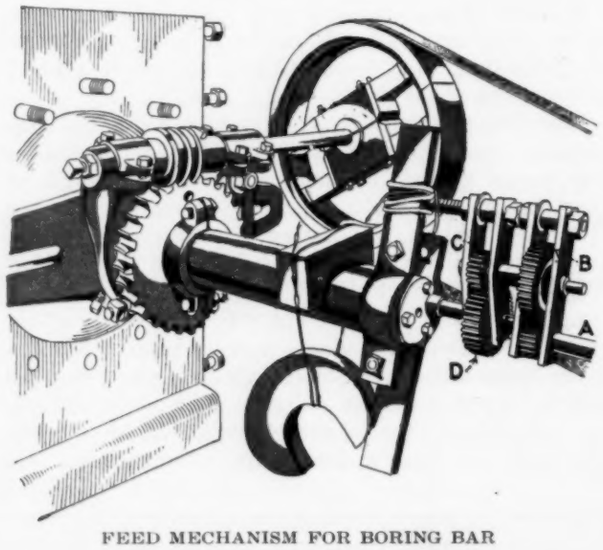
The feed screw has a right-hand thread, 13 pitch. In order to get a forward feed of the tool with a right-hand rotation of the boring bar, the feed screw must make a relative left-hand turn of one-fourth revolution for each rotation of the bar. After a little scheming the arrangement of four gears shown was built up and found to work satisfactorily. The gears are change gears from a lathe. Four bars of flat steel, a long threaded bolt and two short pipe nipples make the frame. Two bars clamped to the boring bar drive the mechanism.

Shaft *A*, with a 24-toothed gear keyed to it, is held stationary and is central with the boring bar. *A* is clamped to a trestle, fastened to the floor. Gear *B* has 48 teeth and turns with *C*, which has 24 teeth. *D* has 48 teeth and is keyed to the feed screw of the bar.

The weight suspended from the wood block shown is used to reduce the vibration and chattering. The right-hand worm and wheel are driven in the direction shown, by a 4½-hp. motor running at 1,400 r.p.m. The bar turns at about 10 r.p.m. The far end of the bar is supported by a bushing in the stuffing-box.

To analyze the action of the mechanism, imagine that the boring bar and feed mechanism receive one complete turn, right-hand, as a locked unit. Then, holding the boring bar still, rotate the gear on *A*, left-hand, one turn to its original position, since it is to remain still. In doing this the feed screw is turned one-fourth revolution inside the bar, which amount is to be its turning relative to the bar for each rotation of the latter. Or, what is the same thing, rotate the small gear once, left-hand, holding the rest of the mechanism still. This, clearly, gives the same relative motion as would be obtained by turning the entire mechanism once, right-hand, about the small fixed gear.

In taking the last cut, it was desired to increase the feed, and two 36-toothed gears were substituted for *A*



FEED MECHANISM FOR BORING BAR

and *B*, doubling the feed. In using other combinations, it is necessary of course to maintain the sum of the teeth of any pair a constant.

The mechanism proved entirely successful, required only material already at hand and was very easily adjusted to the boring bar.

On the Erie R.R., at Hornell, N. Y., the tools are dressed in the forge shop and ground on a Sellers tool grinder in the toolroom. In the accompanying table are given the angles used for all round-nose tools, except those for brass.

Material	Rake, Deg.	Clearance, Deg.	Side Slope, Deg.
Cast iron and tool steel	8	6	14
Machine steel	8	6	22
Tire steel	5	6	9

Lubricating-Oil Testing Machine

By W. B. Slaughter, Jr.

SYNOPSIS—A machine designed for commercial work where various bearings must be used with different degrees of clearance. Thus means for quickly assembling and disassembling are a feature. The coefficient of friction is readily obtained by entering the observations from the machine on a chart.

Following is a description of a machine for testing lubricating oils designed for use in the testing laboratories of Los Angeles County, California. Its principle of operation differs but slightly from that of the typical testing machines on the market, but the manner of applying the load and reading the results presents some new features. The necessity of calculating the coefficient of friction from the results of each test has been eliminated,

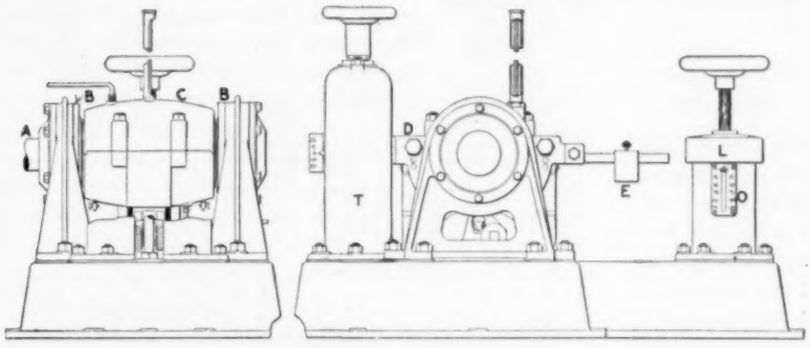


FIG. 1. ELEVATIONS OF LUBRICATING AND TESTING MACHINE

thereby increasing the speed and decreasing the labor connected with the tests. With this machine all lubricating oils used in the county power plants, road-working machinery, shops and automobiles are tested. The contracts for lubricant for these purposes are let after an exhaustive investigation with this machine, and a notable saving over the old method of buying is made.

In general, the machine consists of a motor-driven shaft upon which rides an accurately machined bearing. Loads giving bearing pressures equivalent to those attained in practice are applied to this bearing, while a measured quantity of the lubricant to be tested is fed to the journal and distributed by means of suitable scoring in the surface of the bearing. As the journal is rotated at a known rate of speed, the force of friction acting at a tangent to the shaft tends to revolve the bearing in the direction of travel of the journal. By the magnitude of this torque, or tendency to rotate, the moment of friction is determined. From this the value of the coefficient of friction can be calculated. As previously stated, the peculiar value of the machine in question lies in its method of applying the load, the reading of the torque developed and the absence of calculations in finding the coefficient of friction.

Fig. 1 shows the side and end elevations of the apparatus. The fundamental parts consist of the shaft *A* mounted on two ball bearings *BB*, upon the journal of which is a waterjacketed bronze bearing box *C*. The load is applied to the bearing and journal through a system of knife-edged levers by the mechanism *L*. The force of friction, acting tangentially on the bearing, causes a tendency to rotate in the direction of the shaft motion, which tendency is transmitted through the beam *D* to the reading mechanism *T*. A thermometer well allows the rise in temperature during the test to be ascertained by means of a standard calibrated thermometer, and provision is made to retain the oil used for the purpose of retesting if desired. The bearing is balanced about the axis of the shaft by the adjustable counterweight *E*. The load-applying system is balanced in the same manner.

Since several bearings, representing various commercial conditions, with different clearances on the journal for different lubricants, are used, special attention was given to the matter of disassembling. By the scheme adopted, the shaft and bearing can be removed without interfering with the load-applying system or the torque-reading apparatus. This is accomplished by removing the cap screws *F*, Fig. 2, and the caps *GG*; while unscrewing the nut *H*, thus exposed, leaves the shaft free to be slipped out toward the left. The bearing can now be lifted from the yoke *R*, Fig. 3, and another one substituted. The load-applying system is shown in Fig. 3. The screw *I*, actuated by the handwheel *J*, compresses the spring *K*, which in turn reacts upon the lever *L* through the knife edge *M*. On the spring seat *N* is a pin extending through a slot in the housing, and indicating on plate *O*, Fig. 1, the deflection and therefore the load applied. The lever *L*, Fig. 3, reacts upon the yoke *P*, which transfers the load to the two columns *QQ* bearing against the supporting saddle *R*. All joints are knife edges. This construction allows free rotation of the bearing without disturbing the vertical direction in which the load acts. It will be noted that no motion is transmitted through the lever *L*. It does not back away from the spring as

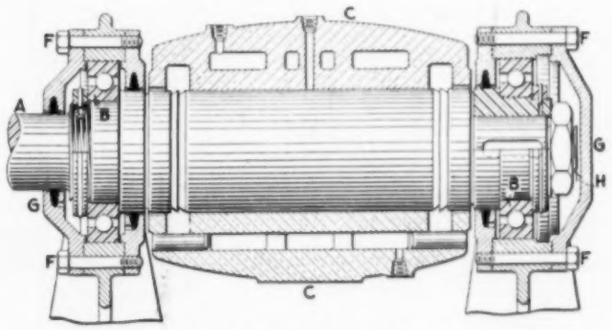


FIG. 2. DETAILS OF SHAFT AND BEARING

the load is applied, which makes the graduation of the plate *O* a simple matter. This plate is graduated by test to read directly in pounds per square inch of projected area of the bearing.

The bearing, resting in the saddle *R*, transmits its rotation to the beam *D* through dowel pins. Fig. 4

shows two views of the torque-reading mechanism, in which the beam *D*, by its downward motion, stretches the tension springs *SS*. This motion also causes the pointer on the beam to fall below the zero line of the dial. By means of the handwheel *T* the screw *U* can be turned

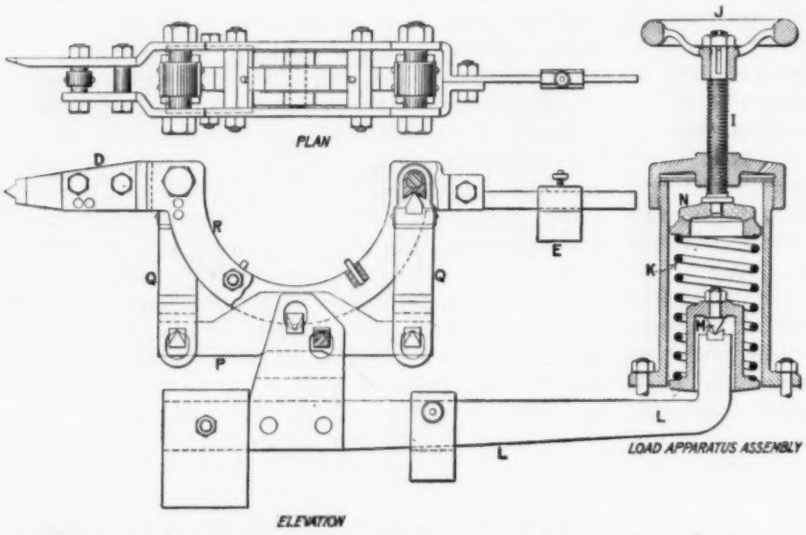


FIG. 3. DETAILS OF BEARING CRADLE AND LOADING MECHANISM

up, putting more and more tension in the springs *SS*, until this tension equals the downward force exerted upon them by the beam *D*. Still turning upward on the screw brings the pointer of the beam opposite the zero line of the dial again. When this condition has been reached (in practice the pointer oscillates over the dial equal distances either side of the zero, like the beam of a sensitive

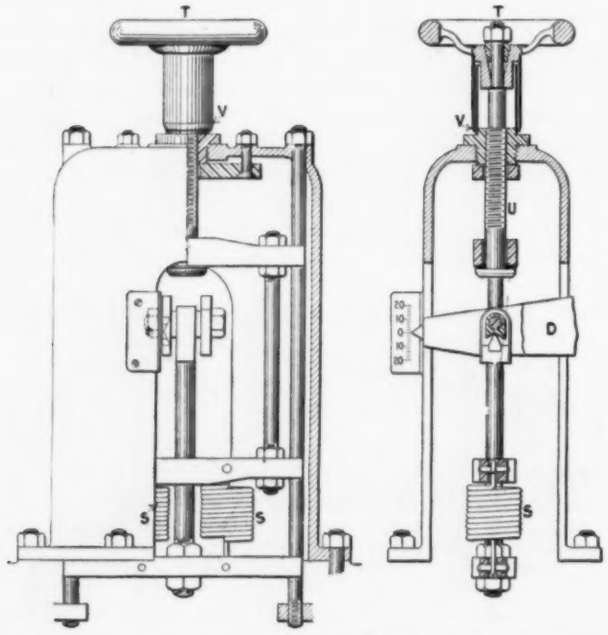


FIG. 4. DETAILS OF TONGUE-MEASURING MECHANISM

balance), equilibrium has been established and the deflection of the springs *S* can be read by means of a micrometer device *V* mounted under the handwheel. These springs having been calibrated by test, the deflection registered gives us immediately the force acting upon them.

To obviate the labor of calculating the value of the coefficient of friction for each test, a chart was made (see Fig. 5) by means of which it is possible to obtain this value directly, knowing the load applied to the bearing and the deflection of the torque-reading springs as registered by the micrometer. This chart is merely the formula

$$M = \frac{4f}{\pi} Pr,$$

plotted to rectangular coördinates, where

M = Moment of friction in inch pounds;
f = Coefficient of friction;
P = Load on the bearing in pounds;
r = Radius of journal in inches.

The abscissas are graduated to read in terms of the micrometer readings and the ordinates in terms of the coefficients of friction. The curve was plotted with five values of *P*, corresponding to the major divisions of the plate *O*. Intermediate values are determined by

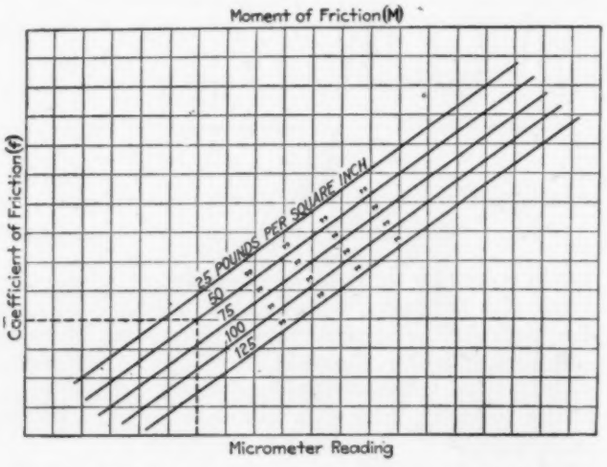


FIG. 5. METHOD OF PLOTTING CHART FOR USE WITH MACHINE FOR TESTING LUBRICATING OILS

interpolation. It is evident that any reasonable degree of accuracy can be obtained by the simple method of making the micrometer sufficiently finely graduated.

Variations in the Properties of steel castings are due (1) to variations in the composition of the steel, (2) to the annealing or heat-treatment to which the steel is subjected and (3) to the soundness of the casting. It was pointed out in a symposium on iron and steel read before the International Engineering Congress that the last of these may be summarized in the familiar saying, "A casting is always a casting"—by which the "initiated" mean that it may always contain hidden blow-holes or shrinkage cavities that cause or aid its failure when least expected. The gases that are liberated from solidifying steel of course cause blow-holes in ingots as well as in castings, but by the time the ingot is reduced to the rolled or forged shape these holes are at least closed up, if not partly welded—and they are generally so located as to be least harmful to the finished piece. In the case of castings the gas from the metal, and the steam and gas set free from the sand mold may cause blow-holes that cannot be detected by surface inspection of the piece.

Letters from Practical Men

A Crankpin-Turning Fixture

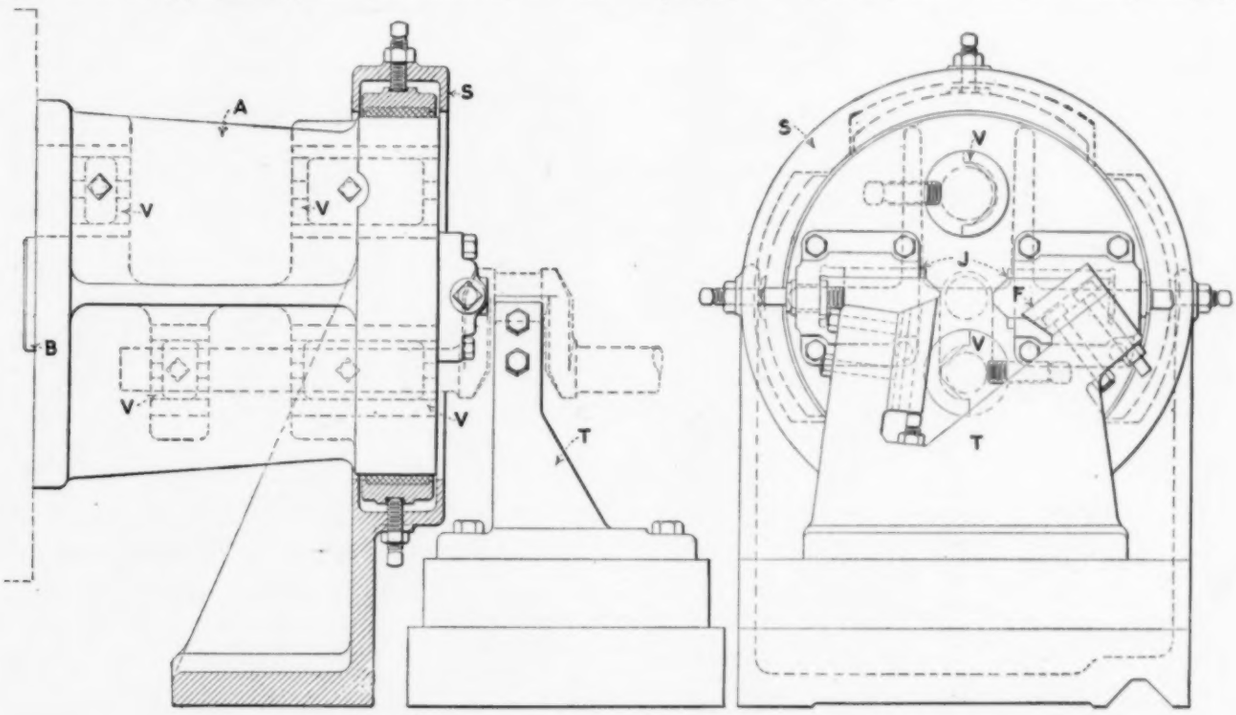
The crankpin-forming fixture shown has effected a remarkable saving in time over the single tooling method of finishing crankpins. In rapidity it compares very favorably with the best grinding practice, while the initial cost is low.

The main casting or faceplate extension *A* consists of two plates connected by a double channel section bolted to the faceplate of the lathe and centered by the boss *B*. The outer plate forms an outboard bearing of substantial width, finished after having been bolted in place. Through this bearing and suitable bosses in the casting, holes are bored at center distances conforming to the throw of the cranks. The same fixture is used for two sizes of cranks, the holes being bored at 180 deg. Fitting in each hole is a pair of V-blocks, one for each end of the shaft. The V-blocks are made from tool-steel bushings, bored to approximately the shaft diameter at each end and relieved about $\frac{3}{16}$ in. in diameter to within $\frac{3}{8}$ to $\frac{1}{2}$ in. of the ends. The outside diameter is roughed down to within grinding limits of the holes bored in the main casting. One-half the bushing, or rather to within $\frac{1}{8}$ in. of center, is then shaped off and the V-block shaped out, the bore at each end giving the required tangent. The V-block is then clamped tightly on a mandrel of the same diameter as the crankshaft and the outside turned to the size necessary for a good fit in the casting. The 8 in. projecting over the center is allowed for calipering. The V-block is then held in place by machine screws tapped into the back. This provides a very accurate, as well as economical, method of alignment.

The crankshaft line bearing is roughed out to within $\frac{1}{16}$ in. of finished size and the shaft forced into the V-blocks by a setscrew on each end, the V-blocks serving as a driver.

On the outside of the outboard bearing is a steadyrest *S*, planed to fit the ways of the lathe and clamped down. The inside diameter is cored to within $\frac{1}{4}$ in. of the diameter of the bearing. Four babbitt-lined shoes fit into cored slots in the steadyrest casting, and are scraped to fit the outboard bearing. They are adjustable for wear and pressure by four setscrews and bear in cored spots in the center of each shoe. This prevents the fixture from lifting under heavy cuts and serves to dampen out any vibration or chatter.

On the outer face of the outboard bearing are bolted two faceplate jaws *J*, of hardened steel. Both are made adjustable for different sizes of crank cheeks, although it is seldom necessary to loosen but one if the forgings are at all uniform. These are made as low as possible.



A SIMPLE CRANKPIN-TURNING FIXTURE FOR RAPID PRODUCTION

The tool post *T* bolts to the carriage in place of the compound rest, and is of as heavy a section as clearance permits. The roughing tool is on the operator's side and is of high-speed steel. In the back side is milled a T-slot, aligned by a gib in the tool post and carrying two substantial bolts. The tool is further supported by a jack from below, giving easy adjustment for wear and grinding. The tool has 7 deg. clearance and 20 deg. rake, all grinding being done on the face.

The finish-forming tool *F* is directly opposite, but at a 45-deg. angle, to keep the cutting edge as close as possible to the point of support. This tool is of carbon tool steel, as it takes off but 0.005 to 0.007 in. It must be kept honed to a fine edge. On account of the light cut, it was found unnecessary to provide a rear support. The tool is held in place by two bolts in a T-slot, but is not gibbed to the tool post. The outer bolt has an eccentric head, and has a square milled below the nut. The object of this is to allow the tool to be squared with the crankpin, as a slight variation will result in a tapered pin. The roughing tool is squared by the setting of the tool block on the carriage and the finishing tool adjusted until the crankpin is of uniform diameter.

The lathe is provided with a two-speed countershaft, giving a roughing speed of about 15 ft. per min. and a finishing speed of 40 ft. A copious supply of cutting compound is forced over the work, serving also as a lubricant for the steadyrest. Higher cutting speeds would be possible, but are hardly necessary, as the time from floor to floor runs from 5 to 7 min. The roughing tool will run 40 or 50 cranks between grindings if any care is used in getting under the scale, while the finishing tool requires only an occasional honing. The line bearings are roughed and finished between centers, using a roller follow-rest. The total time on a 3½-in. throw, crank 1¾ in. diameter, ends 13½ and 14½ in. seldom runs over 30 min.

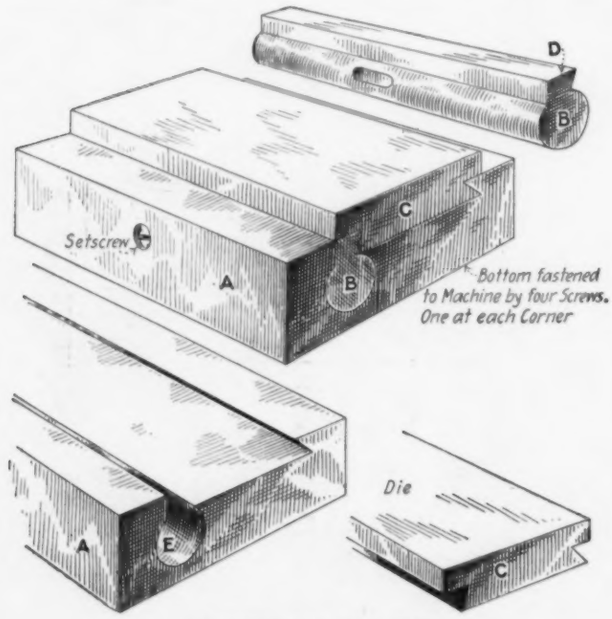
H. E. McCray.

Charles City, Iowa.

A Convenient Die Slide

The die head illustrated herewith was designed in order to make an electrically heated die head, with the heat as near the die as possible, yet permitting the dies to slide easily in and out of the head while hot.

A is the head held to the machine by four screws, one at each corner. The bottom, made of cast iron, is cored



A CONVENIENT DIE SLIDE

out to receive the heating wires. *B* is the gib with which to hold the dies shown at *C*. It is made of steel bar stock and is practically finished in four cuts.

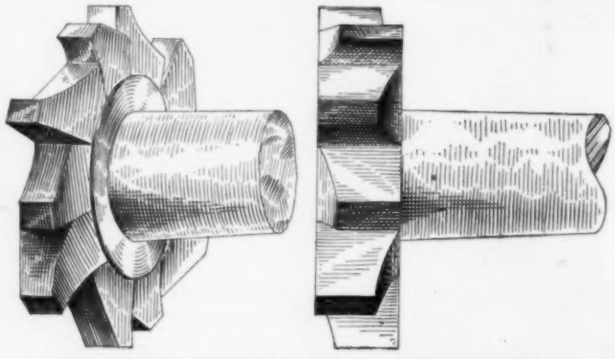
A piece of stock about an inch longer than the finished gib is centered, put on the dividing head in the miller and machined with a concave cutter. Two cuts finish the round, front and back faces of the binding lip *D*. The top of the gib is finished with an end mill making three cuts. The fourth cut saws the end off, which leaves the gib finished with the exception of a flat for the screw that forces the lip *D* against the die. This screw bears on the gib a little above the center of the round, and the method outlined allows the use of a screw that is not continually wearing out. The gib slides into the drilled hole *E* and is held in place by a fillister-head screw.

Leroy Q. Presby.

Melrose, Mass.

Increasing the Chip Space in Woodruff Keyway Cutters

It has been my experience that the cutters usually supplied to cut Woodruff keyways do not have sufficient chip room to clear themselves and take a good cut. If made like the cutters supplied for standard T-slots, they



RELIEVING WOODRUFF KEY SLOT CUTTERS

will cut much faster and leave a smoother seat for the key. We do this, as shown in the illustration, by cutting away alternate teeth with an end mill. It costs a little more, but it pays in the amount of work that will be turned out.

P. Petrenar.

Rockford, Ill.

Preventing Rod Vibration on Automatic Screw Machines

Brass rod of square or hexagonal shape, when used in automatic screw machines and run at a speed suitable for this material, is apt to make a lot of noise. What is worse, it will usually suffer more or less abrasion of the corners when, as is usually the case, it is supported in a length of iron pipe. If the rod is even slightly bent the troubles are increased.

It was to overcome these difficulties that we made a set of carriers like Fig. 1. This carrier is simply a shell or bushing about 2 in. in diameter and 6 in. long with bushings ½ in. thick driven and pinned in each end. These bushings are broached out about 0.010 in. larger than the size of rod they are to be used with.

Before fastening the bushings into the shell we riveted in the flat springs as shown by sketch, using four springs for square rod and three for hexagonal, the object being to hold the carrier on the rod when it was slipped over the outer end.

As a guide for these carriers we provided a length of tobin bronze tubing and took precautions to keep it in line with the spindle of the machine. This worked very successfully on rod from ¾ in. to 1¼ in. across flats, running at about 900 r.p.m.

Later, however, when we tried the same method with rod of the section and size shown at Fig. 2, running 1,200 r.p.m., we found ourselves strictly up against it on account of vibration caused by the rod being out of balance Bracing the pipe rigidly did not help matters much, but when we clamped several hundred pounds of iron on the pipe at each support the rod ran as quietly as any round rod could.

We next took another machine at the same speed, 1,200 r.p.m., and replaced the regular pipe holder with solid

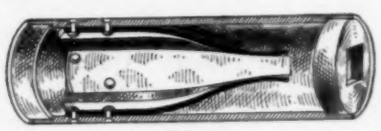


FIG. 1

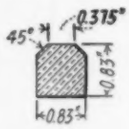


FIG. 2

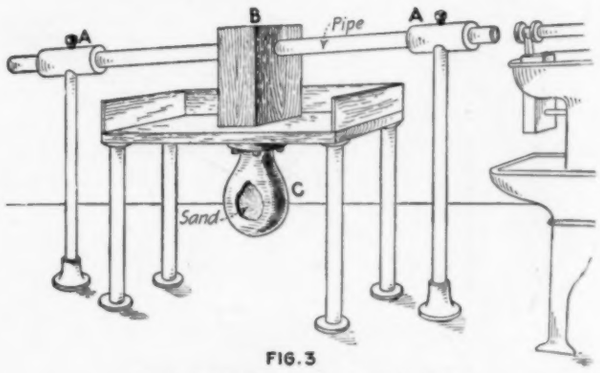


FIG. 3

ELIMINATING ROD VIBRATION

castings 6 in. in diameter by 12 in. long, *AA*, Fig. 3. The result was that these heads remained practically motionless while the pipe vibrated at least ½ in. between the heads, more in fact than seemed possible. A heavy bench stood just under the pipe, so the wood block *B* fitting the pipe closely was bolted to the bench, but little improvement resulted.

Having a discarded pump air chamber, we filled it with sand and bolted it to the table as at *C*, directly under the block *B*. This proved a solution, reducing the vibration to almost nothing.

The appearance, however, of this array of inertia material was not exactly ornamental, and it would be interesting to know how others have overcome these troubles.

RAYMOND GRANT.

Norwich, Conn.

Watch Face as Protractor

During my past summer vacation in the backwoods it happened one day that I wanted to lay off approximately an angle of 60 deg. It also happened that my watch was lying on the table in my rustic quarters, and by chance I suddenly realized that its face would serve as a reasonably good protractor. The accompanying illustration shows what I mean.

At the time it struck me as rather odd that I had never before seen a "protractor" in a watch face. On my return to civilization I amused myself by asking about every other person I met if he had ever used a watch as a protractor or ever heard of such a thing. I kept this up for several weeks and asked scores of people, engineers and professional men, and with the exception of one young civil engineer who had used the watch face to judge roughly an angle in the field, I did not meet one man to

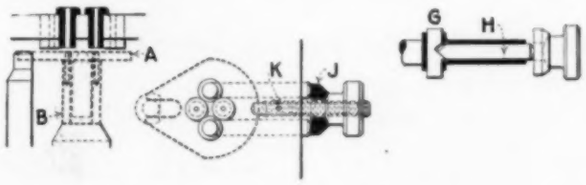
USING WATCH FACE AS A PROTRACTOR

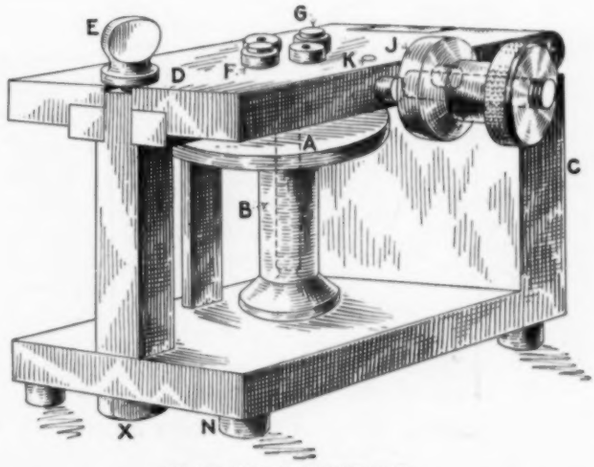
whom the whole idea was not a sort of amusing surprise. I do not suggest for a moment that the "discovery" is of great value, but it was a source of momentary convenience to me, and perhaps it is worth passing along. With a little care it is possible to lay off any required angle within a very small margin of accuracy.

Pittsburgh, Penn. GEORGE H. FOLLOWS.

A Feather Pinning Jig

The piece for which this jig was made is a ⅛-in. cold-rolled steel punching fitting on a cold-rolled steel hub *B*. The piece *A* must be located on the hub and





FEATHER PINNING JIG

pinned. The jig is made with a machine-steel forging *C* and a lid *D* held down by the thumbscrew *E*. The bushings *F* carry the pins *G* and have a 45-deg. angle

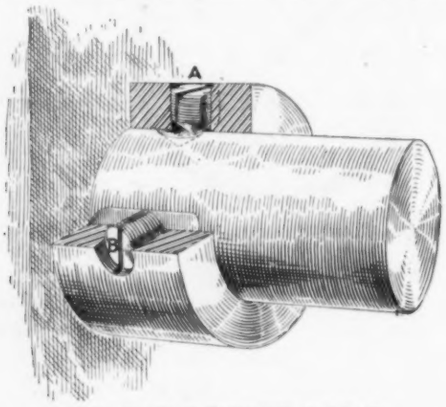
milled in them. The pins *H* fit in the angles and are worked by a nut and floating washer *J*.

The screw *K* is threaded its full length and screwed into the lid and bottoms in the threaded hole. A small pin *K* is used to keep the screw from coming out, the threads taking all the thrust. B. H. RICHARDS.

Dayton, Ohio.

Adjustable Thrust Collar

The collar shown is made of the desired dimensions with screws to suit. The screw at *A* is pointed at the same angle as the spot in the shaft. The spot is placed a little in advance of the center line of the screw. The



ADJUSTABLE THRUST COLLAR

screw *B* has a flat point that seats on a flat spot on the shaft.

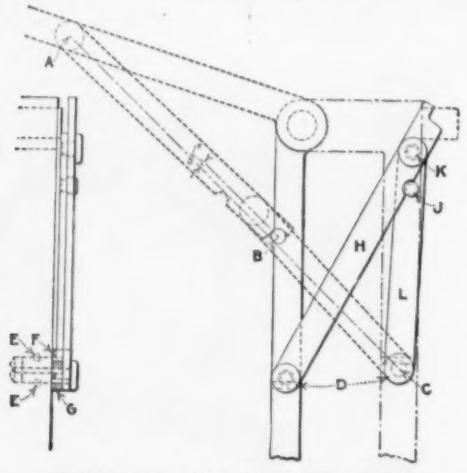
To take up end play where this collar is used, screw in *A*, which moves the collar to the desired position. Then bind it with screw *B*.

I have found this a simple means of adjustment.

Ilion, N. Y. HAROLD E. GREENE.

Hinge Lid Stop for Large Jigs

A lid stop for large jigs is shown herewith. The full line shows the hinge stop when the lid is down, and the



HINGE LID STOP FOR HEAVY JIG

dotted line shows its position when the lid is up. It will be noticed that points *A*, *B* and *C* are not in line and that point *B* is ⅛ in. from a line drawn from *A* to *C*. This is done so as to enable the lid to be closed without touching the hinge.

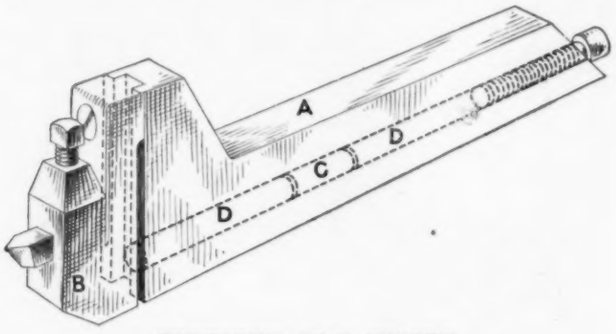
All the parts are made of cold-rolled steel case-hardened. The holes drilled in the lid and body of the jig are a snug fit for studs *D*, which are held in place by pins *E*. The spacing collars *F* and *G* keep the hinges from striking the jig and also each other. The half-round cut in hinge *H* is merely a clearance cut for stop stud *J*. The stop stud *J* and the stud *K* are driven and riveted in hinge *L*. M. BASSETT.

Dayton, Ohio.

Spring Threading Tool Holder for Square Bits

Although the *American Machinist* has shown a number of spring threading tools in the past, another good one may not come amiss.

The tool shown is almost self-explanatory. It consists of a shank *A* and a tool head *B*. The tongue on the tool head works in the slot in the shank head and prevents the tool from deflecting sideways when large



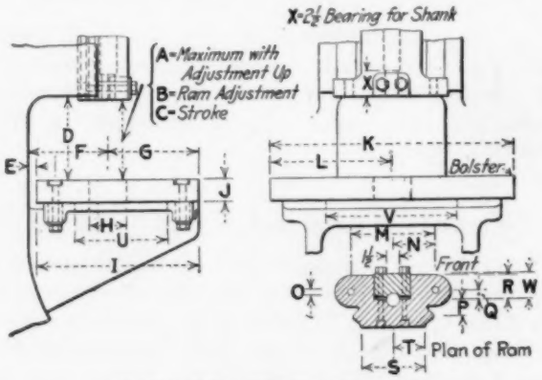
THREADING TOOL HOLDER

threads are being cut. The tension screw through the shank can be set up to give the desired spring; or by taking out the leather buffer *C* and bringing the two rods *D* together and against the tool head, it becomes a solid tool. WILLIAM C. BETZ.

New Britain, Conn.

Data for Punch Presses

In the illustration are shown data on punch presses that may be found useful by designers in making punch and die tools to be used on No. 4 and No. 5 Adriance



DATA FOR PUNCH PRESSES

presses. There are also supplied data required by the designer regarding the minimum and maximum sizes of tools which can be used in operating.

Hartford, Conn. W. F. O'CONNER.

Discussion of Previous Question

Manufacturing Rifle Cartridges

I have read with interest the article on "Manufacturing Rifle Cartridges," Vol. 43, page 881, and I must object to several things.

For a modern shop how crude is the metal reel used in Mr. Smith's Fig. 5! Nearly all press manufacturers build a sheet-metal reel that is practical, to say nothing of being graceful, for a price that would almost put this one out of consideration.

Personally I should not want to wind sheet metal 0.080 in. thick with an opening much less than 3 in. in diameter instead of almost nothing, as he has shown in operation 1. In this operation we see a strip of metal 2⅝ in. wide planned for anything but economical blanking. The established width for the wall between blankings in sheet-metal work must be equal to the thickness of the metal blanked, except in very thin stock. I have allowed a maximum wall width, one and one-half times the thickness, and by economical location of the punchings I get two blanks across the width of a strip of metal $2\frac{5}{16}$ in. wide, three rows of blanks from a 3⅜-in. strip and four rows from a 4⅜-in. strip. The minimum of 0.080 in. wall width could have been used instead of 0.120 in. with a further saving.

This layout for blanking is shown in Fig. 1 herewith. There would be some difference in the amount of scrap at the end of a day's run between the two methods. If two rows of blanks are to be cut, punches would be set as indicated by circles, marked 1 and 2, Fig. 1; if three rows, as at 1, 3 and 4; and if four rows, as at 1, 3, 4 and 5. The finger stop for the feed of the metal is set in the first circle to the left of the punch, that is, farthest to the right.

It will be noted from Mr. Smith's operation 1 that the four blanks are cut in one die. Even with a wall of ¼ in. at the cutting edge of the die, I do not see how his dies can stand up as long as he specifies. Not only is the wall thin, but making more than one die out of one piece of steel to be hardened is very impractical.

In hardening, the dies cannot but change their shape somewhat, and the problem of getting the punches and dies to line up properly is quite difficult. The stripper is about as well designed as the die itself. What would happen should the plunger used for stripping the shell from the drawing punch turn around 180 deg.?

I now refer to Fig. 2 herewith, in which *A* is the die. It will be noted that there is as generous a radius between the blanking diameter and the drawing as their respective diameters will allow, which makes the shell draw easily. The bottom of the die is relieved as shown. The time required to cut this relief is almost nothing, and you have formed as simple and positive a shell stripper as could be desired. The shell is bound to expand some as soon as it has passed through the die, which will prevent it from going back up through the die with the drawing punch.

At *B* is a steel die holder in which the dies are held by retaining rings *C* screwed into *B*. The outside of the die and the inside of the ring are both tapered 10 deg. so that the die is drawn securely down on the die holder. At *D* is an ordinary stripper for the blanking die; at *E*, the blanking die; and at *F*, the blanking-die holder, a steel drop forging shown in detail in Fig. 3. The drawing punch *G* has a vent hole which Mr. Smith does not show, and shells will surely stick to the end of the punch unless there is some way of getting air to the end of the punch to relieve the vacuum held by the pressure of the punch on the metal. In large work a spring plunger is added to the end of the punch to help separate the shell from the blank. There is a slot cut on opposite sides of the upper end of the punch to suit a holder on the upper gate of the press. This allows a condition of practical floating, in that the holders may be clamped in position

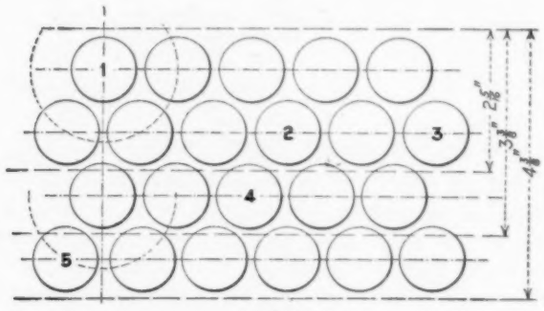


FIG. 1

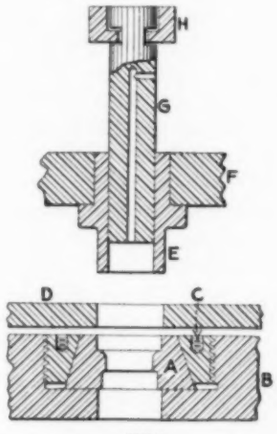


FIG. 2

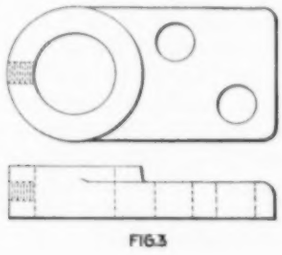


FIG. 3

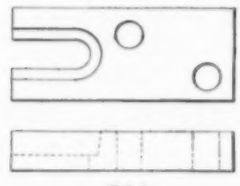


FIG. 4

FIGS. 1 TO 4. DETAILS OF BLANK SPACING, METHOD OF STRIPPING SHELLS AND PUNCH AND DIE HOLDERS

Fig. 1—Layout for blanking rifle cartridge-shell blanks. Fig. 2—Blanking and cupping die for rifle cartridges. Fig. 3—Blanking-die holder. Fig. 4—Floating drawing-punch holder

and the holes for *F* and *H* tapped in their respective punch-holder plates. The detail of the floating drawing punch holder is shown in Fig. 4.

In dial-feed presses the dial is generally so designed that the shell is located upright, so that no locating of the shell in the drawing die is required as Mr. Smith has shown in each redrawing operation except the first one. This saves materially on the stroke of the press.

Uptodate gages are being shown in nearly every issue of *American Machinist*, and I fail to see why any company should use such a crude gage as is shown on page 887.

The table herewith arranges the details of the six operations shown in Mr. Smith's article, to which I have added the minimum number of strokes of the press that each shell could be drawn with, for 110 r.p.m. is a pretty

PRESS PRODUCTION TABLE

Operation No.	No. of Machines	No. of Tools per Machine	Time, Hr.	Production	Stroke of Press	Life of Die in Number of Blanks
1	1	4	10	250,000	110	2,500,000 3,000,000
2	2	2	10	200,000	100	1,000,000 1,500,000
3	2	2	10	200,000	100	1,500,000 2,000,000
4	2	2	10	200,000	100	2,000,000
5	2	2	10	200,000	100	2,000,000
6	2	2	10	200,000	100	2,000,000

good speed to run a heavy geared cam drawing and blanking press of the type illustrated by Mr. Smith. I should say that 100 r.p.m. was pretty high to run a dial-feed drawing press with a stroke of 2½ in. at least, but I would like to be shown before I believe that a press can draw the same number of shells per minute with a 6¼-in. stroke.

The life of the die for operation 6 is one-third more than the life of the die for operation 2, yet the wear from friction is nearly five times as great. I question whether the difference in the reduction in the thickness of the walls of the shells will give this difference in the life of the dies.

It is my opinion that Mr. Smith must have been misinformed regarding the speed of presses, the design of modern blanking and drawing dies and the life of the dies.

J. W. MAYNARD.

Hartford, Conn.

Counting the Number of Teeth in a Wheel

On page 1044, Vol. 43, Mr. Fletcher tells us how to count the teeth of a gear wheel. His suggestion hit me so squarely in the neck that I went through my shop, and I did not find anyone who had not had the same trouble, counting around two or three times to get the count right. When I told them to mark a space and to count around from it, they all saw the point.

JOHN E. SWEET.

Syracuse, N. Y.

Suggestions from Employees

I have read with great interest the editorial on "Suggestions from Employees," appearing on page 1001, Vol. 43. From my own experience I agree with the statement, "No shop has ever yet worked the system in a strictly fair manner."

I have worked in several shops where the system has been installed. In one my suggestion was approved by the superintendent and disapproved by the foreman. It was tried, proved a success, and after a couple of months I received a liberal reward. But after that I was slighted by the foreman, and the best thing for me to do was to leave.

In another shop we did not have a suggestion box. The employees had to give the suggestions to the general foreman. He seemed to be very fair at first; but afterward he told the employees, when they suggested something, "That is the way we make them in England and later on we are going to make them that way here." (The firm had several branches in Europe.) Later the suggestion box was installed and opened only by the president of the firm.

On a certain article an operation had to be performed on the vertical miller. I suggested to the general foreman that it could be done on the drilling machine. He told me that they had tried it in England, but it would not work. I put this suggestion into the suggestion box and received an order from the superintendent to proceed with the tools and fixture for the drilling machine. It proved a success and reduced the cost of production to about 40 per cent. of what it was before; but soon after this I had to look for another job, because the firm moved to another town and laid off nearly all of its employees.

So after about three years of faithful service I asked for a reference, which was given to me and which winds up like this: "Owing to the moving of the factory to another town, we are compelled to discharge him." That was the only reward I received for that suggestion.

I think it would be advisable to keep secret the name of the suggester from the general foreman and foreman unless they have been proved to be broad-minded and fair men.

CHARLES GUTMAN.

Chicago, Ill.

A New Design for Reducing Gears for Aero Propellers

Although now in Great Britain, a refugee of war from Belgium, I am a Russian, and have spent more than twenty years, half of my life, in the drawing offices of Russia, France, Germany, Belgium and finally, because of the war, in Great Britain.

Mechanical draftsmanship has been for me the periscope through which I looked at life. And though I have often been bored with it, I hold the conviction that mechanical manifestation is one of the most important in life. In my own experience, every time I was ordered to search and to invent, I was happy and enjoyed my work more than anything else.

My last experience as designer here in Great Britain, which I am to relate, and which may be of interest, was in aëro-engine work. I was confronted with the problem of designing a device for reducing the speed of the propeller shaft, the engine being of 250 hp., 12-cylinder, inclined at 60 deg. and running at 1,200 r.p.m. The propeller had to be in line with the crankshaft and be driven at a speed of about 550 r.p.m.

Epicyclic gearing was tried, but it could not be made small enough. I finally came to the idea of a stationary pinion as a means of reduction, and the whole device took the shape shown herewith.

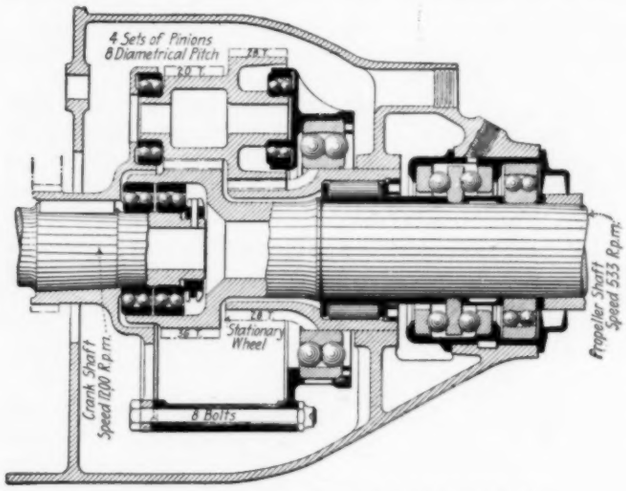
The stationary pinion has 28 teeth and is held firmly in the crank case by two long bolts going through the case and over the top of the pinion. The propeller shaft

passes through the stationary pinion and runs on ball-and-roller bearings. It carries a gear of 36 teeth running on internal ball bearings forced on the end of the crankshaft of the engine. It meshes with a 20-tooth pinion. Four sets of stepped, or cluster, pinions run around the stationary pinion, being held in a cage keyed on the end of the crankshaft and guided on large ball bearings on a stationary pinion. One set is shown at the top. The result of this combination as regards the reduction of speed may be expressed as follows:

$$36 : 16 : : 1{,}200 : 533$$

Thus the propeller shaft will make 533 r.p.m. with the motor at 1,200 revolutions.

I have read that the chief difference between an American and a European constructor will be shown at once if both are given the choice of two solutions of a me-



REDUCING GEARS FOR AERO PROPELLERS

chanical problem, one of which is already in practice and the other quite new. The European will choose the old one so as to profit by past experience, while the American, confident of his own judgment, will jump at a new idea.

So it proved to be in the present case, for when submitted for official approval my idea was criticized and rejected as being new. I believe my idea of the stationary pinion is good, and I hope also that some American will take it, think about it and design some better and more practical device for the benefit of the mechanical world, not forgetting to credit a Russian mechanical draftsman with the idea. MICHEL BALKACHINE.

Dumfries, Scotland.

Useful Relation Between the Squares of Numbers

Referring to Mr. Olds' communication in the *American Machinist,* Vol. 43, page 1126, on a simple method of obtaining the difference of two squares, a still simpler relation is:

$$a^2 - b^2 = (a + b)\ (a - b)$$

Mr. Olds' problem then becomes:

$$701^2 - 679^2 = 1{,}380 \times 22 = 30{,}360.$$

Elizabeth, N. J. DONALD M. LIDDELL.

On page 1126, Vol. 43, D. S. Olds shows an easy method of obtaining the result of the expression $a^2 - b^2$, by expanding it. It seems to me that an even easier method is to use the factors $(a - b)\ (a + b)$. As the results of the addition and subtraction can be set down directly, there is only one multiplication to perform, against two in Mr. Olds', besides the other operation. Moreover this expression is easier to remember, being only the product of the sum and the difference.

Rochester, N. Y. S. E. CORY.

Europe as Market for American Machinery After the War

On page 861, Vol. 43, appears an article by F. C. Cornet, on "Europe as a Market for American Machinery After the War." In the same issue is an editorial on this subject, on page 871. On these articles I should like to comment; and I will premise my remarks by stating that as an English engineer I have been, during a long period of years, and am still, a purchaser and user of American machinery, and in common with most English engineers bear tribute to the general excellence of your productions which, like good wine, need no blush.

The tenor of the article, in anticipating further remunerative trade arising from the war, is couched in terms which are offensive in their deductions and remind one of those ghouls who speculate at a bedside as to what a relative will leave, before breathing has ceased.

As a regular reader of the *American Machinist* and one who has closely followed and admired its straightforward and dignified policy, I feel sure that you would not willingly create a false impression on this side, and therefore I desire to comment on two aspects of the article.

Mr. Cornet may have an extensive knowledge of some parts of northern France and Belgium, but possibly he will allow one who also knows the districts in recent years to say that his statements and conclusions as to engineering practice, the standard of home life and the methods of commercial routine do not apply in a general way to the districts named and are exaggerated or much overdrawn. His statements regarding the "Old Country," as to office routine, are absolutely untrue in a general, or even a very limited, sense. Conversant as I am with every town and city of the United Kingdom, I say that Mr. Cornet was either grossly misled by someone who "pulled his leg," or else has adorned his tale, by writing that (a) clerks in a large office earned an average wage of 16s. to 17s. per week, and (b) that not one of them had ever seen a typewriter, and that (c) the head clerk after 34 years' service only received £80 per annum. There is much that is good in Mr. Cornet's article, and it is a pity that such misstatements should have been allowed to spoil it.

The second aspect on which I desire to comment is this: That it is not, in Great Britain or Europe, looked upon as good form to discuss, during a quarrel, the possible favorable outcome for oneself that may arise from the probable exhaustion of the combatants, and it is hardly in good taste that such a discussion should appear in a journal that caters for and has received a considerable amount of support in Europe and Great Britain.

In the midst of a wave of abnormal and profitable trade arising from the war, the Allies would better respect some Americans if they acted and spoke more modestly as to the reasons for their present prosperity in

stead of continuously harping on the dollar that is and the dollar that is to come.

Speaking for my own country, let them try to appreciate the absolutely disinterested reason or duty that led us to take our part in the war; let them also try to appreciate the spirit of a nation that, having already half a million of casualties in the field, is prepared to face three or four times as many for no ulterior benefit, but because we always have stood and always shall stand to our bond. Let them also realize that in our organized effort to win the war we deliberately sacrifice our trade and discount our future prospects.

The realization of our efforts and sacrifice will, I believe, make our cousins see that after all it is only the self-respect or the soul of a nation that counts, and that the present time is not one for any neutral nation publicly to weigh up or estimate future profits arising from the misfortunes of others.

We have no necessity for the active help of any others than our present allies, and we shall finish this job in a manner which will prevent a recurrence for another hundred years; Europe after that settlement will be a better place to live in. Further, we are not afraid of any start that the present circumstances gratuitously give to any of our competitors; all we say is that for any benefits you are now reaping, be modest and do not shout about them. We appreciate and value not only the vast volume of American opinion that is favorable to and wishes success to the Allies, but the material help that your large concerns have been able to render.

Permit me to conclude that, as one who has very many friends among American engineers, my one object in writing at such length is to correct for the benefit of the few the impressions and erroneous deductions in the article in question, which I feel sure are not held by the great majority of Americans, and to wish sincerely that the very pleasant relations that exist between American and British engineers may continue and grow in accord.

London, England. HERBERT A. JONES.

[Mr. Jones, in the preceding letter, shows first, that he has failed to read Mr. Cornet's article carefully, and second, that he fails to understand the American attitude and viewpoint in regard to the increase of business due to the war. In his third paragraph he quotes three comments from Mr. Cornet and states in substance that they do not apply to conditions in the United Kingdom. Here he falls into error, for Mr. Cornet was discussing the situation in Belgium and northeastern France, not in Great Britain.

In his second paragraph he states in substance that the American attitude, as indicated by the article that he is discussing, reminds him of "one of those ghouls who speculate at a bedside as to what a relative will leave, before breathing has ceased." Nothing could be farther from the facts, and again Mr. Jones must be charged with careless reading. In the last paragraph of the editorial to which he refers are these sentences:

"The allies of Belgium, who would naturally have the first privilege of extending help in this rebuilding, will unfortunately have similar conditions to meet at home. The enemies of Belgium will be barred by hatred. Thus, American engineers must play a big part in this work of reconstruction."

This indicates the duty which Americans feel toward the rest of the world in an endeavor to keep things going while the producing nations of Europe are prevented from carrying on their usual tasks. This attitude is succiently summed up in the opening paragraphs of the "Report of the Chief of the Bureau of Foreign and Domestic Commerce." He writes:

"The world situation as it exists today is for this country [United States] one of opportunity and one of obligation. Our opportunity lies in the fact that the business community is aware of the existence of foreign markets, sees the advantage of securing them, and is now positively desirous of doing an export business. The European War has advertised foreign trade to the American business man. The mere fact that our chief competitors are at present otherwise engaged is of merely temporary interest. The obligation which rests upon our business opportunity is to fill, for the time being, the rôles in the world's markets voluntarily laid aside by the other great nations of the world. We must supply to the newer countries raw materials, manufactured goods, finances and most important of all, enterprise. Of no less importance, we must supply a market for the products of our new customers. The obligation of our present situation is as great as the opportunity, for we have in our power the well-being of many other nations."—Editor.]

Repairing a Broken Crankshaft

In reference to Mr. Miller's remarks regarding crankshaft repairing, on page 254, Vol. 43, I must say that I was sorry to see that the illustrations had been wrongly shown. The mistake made the crankpin appear to be conical. When I noticed the error in print, I thought it was so obvious that no one would be led astray and consequently did not trouble to correct it.

I very much appreciate the remarks on "Objections to Welding Crankshafts," but should another case come my way I should feel inclined to try my luck once more.

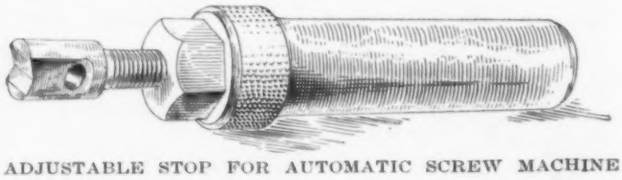
As to Mr. Miller's further remarks on welding, I wish to take this opportunity to thank him for having added a fair amount of useful information on a comparatively new and interesting subject. H. HELLFRITSCH.

Stockport, England.

Adjustable Stop for Automatic Screw Machine

In the past several adjustable stops for the automatic screw machine have been shown, and while many of them represent improvements, unnecessarily complicated design is often found in these devices.

Herewith is shown the best adjustable stop that I have ever seen for the automatic screw machine. The stop



ADJUSTABLE STOP FOR AUTOMATIC SCREW MACHINE

was used on the No. 0 Brown & Sharpe screw machine and gave perfect satisfaction. Its construction is very simple. The face is spot drilled to allow clearance for teat of stock left by the cutting-off tool.

Harrisburg, Penn. JOHN HOFFMAN.

Editorials

Reasons for Finding Costs

Truth, essential truth, has never before been revealed in such clearness to men of this generation as during the year just passed. Both new truths and sidelights on old truths have been disclosed. National aspirations, racial ambitions and commercial envies are now evident to all who read and reflect. And in the realm of smaller affairs some of the controlling forces of industry are now recognized as they have never been recognized before.

The beams from one of these sidelights have illuminated the matter of pricing machines. We may have fondly believed that selling prices depend upon costs, for we have been told this over and over again and have been given a wealth of supporting arguments and a score of illustrations in an attempt to prove the truth of the statement. But when we see a tremendous increase in price, which in a single case has carried one machine from $550 to $1,600, we question the direct relationship between the probable increased cost and the actual increased selling figure. The first may have increased 25 per cent.; the latter has gone up nearly 200 per cent.; and this is no isolated example.

Thus the truth is revealed to us that selling prices rest on other things than cost. To be sure, some observers have always held this. Some have said that the selling price for a machine is fixed by the builder's competitors. Others have said that the price is whatever the traffic will bear. So far as the present situation is concerned, the latter statement seems to be true. The prices of machines in this country have advanced in keeping with the desperateness of the needs of European and domestic buyers.

When we have reached this conclusion, the question naturally follows, What are the reasons for finding shop costs? It is commonly supposed that they are obtained to fix prices. But if prices are largely governed by factors other than costs, there must be some less apparent reason for cost finding, if cost finding is worth while.

The practice of some progressive firms gives us a tip as to the more important reasons for establishing and maintaining expensive cost departments. Among these are: To govern policy and to control costs. To sum up, with an attempt to arrange them in order of importance, we now have these three reasons: To control costs; to govern policy; to set prices. The first comprehends improvement in manufacturing efficiency and the elimination of waste. The last is of far less importance than either of the others.

If prices are set by what the traffic will bear or at what a manufacturer can sell for with profit under competition, it follows that shop costs must be sufficiently below those prices to return a proper manufacturing profit. Whether they are or not, governs the policy of continuing in that line of business, dropping out or so modifying the methods of manufacture or sales as to put the business on a satisfactory basis. Before details of policy can be worked out, the costs must be known.

Once a definite business policy has been decided upon, based upon possible cost, it follows that the assumed cost must become a reality, else the business will run toward the rocks. Here is where the necessity for control of costs enters. And this in turn is probably the most important function of cost keeping.

In any shop a few most pertinent questions can now be asked: Is the cost-finding system operated in such a fashion that it supplies information, first, to control costs; second, to determine policy; and third, to assist in setting selling prices? If it does not do all three of these in a satisfactory manner, it is not meeting its responsibilities and should be reconstructed. The too frequent situation—where the cost department merely accumulates "records," which are late in being compiled, lacking in vitality and left unused from year to year—has no excuse whatever for being. A healthful treatment for such a situation would be to send the records to the boiler furnaces, discharge all the help, dust the place clean and begin over again. There have been cases where just such drastic action has been taken, with final results that were profitable.

Influence of the Automobile on Machine-Tool Design

The direct and indirect influences exerted by the automobile on machine tools during the past ten years are seldom realized. They have all been in the direction of improvement. A brief résumé of automobile manufacture of a decade ago is interesting and affords an opportunity for reflection on the development of our present-day high-grade metal-working machines.

Ten years ago most of the high-grade automobiles were made abroad—chiefly in France and Italy. In their production toolroom methods were used—long, tedious boring and reaming operations were the rule and laborious laying-out was everywhere in vogue. The motor and transmission gears were hardened, often singly, and then "run in." A train or pair of gears was placed on studs that could be gradually brought nearer together until the correct pitch centers were found for as silent running as it was then possible to obtain.

The machining of the cylinders was a similar slow process. They were usually bored with a single-pointed tool and then reamed with a multiple-edged tool. In many cases the bores were finally lapped by hand, using a long cast-iron cylinder or drum charged with abrasive material. This process was continued until the more or less inaccurately bored holes were straight and cylindrical.

In those earlier days firms in this country followed like methods when making what was known as high-grade—another term for high-priced—cars. It is true that there were also medium-priced cars, but these were usually about as noisy as a threshing machine that needs oiling and general overhauling. It was at about this time that the American public, appreciating the value

of the automobile, demanded a car as easy running and silent as the expensive foreign product of the millionaire. At this stage of the development of the industry the machine-tool builder's help was epoch making.

He designed and made the machine tools which have produced a medium-priced automobile with the ear-marks and possibility of satisfaction of the high-grade and high-priced cars, whether of foreign or domestic manufacture. In step with him came the special tool designer developing jigs, fixtures, gages, cutters and the like, so that the parts for these new vehicles could be produced to the best advantage. One of the problems—that of machining circular parts in parallelism—was solved by special types of lathes and automatics. Another problem—that of producing a satisfactory finish—was overcome by grinding parts so that the surfaces are both smooth and true. For this purpose several new types of grinders have been evolved.

The miller has also kept pace in the onward stride for better machine tools, so that surfaces are now machined quickly, smoothly and to interchangeable contours. The gear cutter—planer or hobber—has enabled the manufacturer to produce gears with any proportion and shape of tooth desired. He can now turn out all the gears in a set with a certainty of having the same tooth outline and thus interchangeability in their manufacture.

The advent of high-speed steel and its effect in increasing production are too well known to require comment here. But hardening furnaces, pyrometers and heat-treating devices have added their quota to the success of the movement that the newer steels initiated.

Briefly, as a result of these and other developments, shafts, pins, studs and other cylindrical parts are now produced without bothersome suboperations such as filing. Holes are bored so that shafts fit for their entire length, and the former slow operation of scraping to obtain a satisfactory bearing is seldom resorted to. Cylinders are machined and ground so that the piston has an equal bearing pressure for the entire length of the bore. The tedious cut-and-try lapping method of final finishing is now a thing of the dark ages of automobile building. Gears are machined, hardened and made ready for use without any running-in being necessary. By the use of special machines and small-tool devices—jigs, fixtures and others—parts are now produced more quickly and cheaply than ever before and with complete interchangeability.

As a final assembled product we now have automobiles not only in the medium-priced but also in the low-priced class which for ease of manipulation and silence in operation compare most favorably with the high-grade, high-priced cars of a decade ago. An old adage says, "Necessity is the mother of invention." The people of this country needed automobiles that they could pay for and enjoy. The machine-tool builders supplied the means for producing them. The high-grade machine tools of today owe the stimulus for their development in great measure to the need for the motor car.

To a similarly high degree the automobile industry has left its mark on the development of the now common alloy steels. Many of these steels, possessing qualities of strength and durability which were almost undreamed of before the automobile sprang into commercial existence, owe their very conception to motor-car service.

An Industrial Responsibility

The importance of industry, the vital need of engineering direction and even the overshadowing of financial matters by manufacturing requirements in warfare were emphasized at the banquet of the Society of Automobile Engineers. Secretary of the Navy Josephus Daniels pointed to the record of England. In the early days of the war the British nation congratulated itself on having at the head of the imperial finances such a strong, able man as David Lloyd George. His success in mobilizing the financial resources of the British Empire is known to all. But as the war progressed, a greater need appeared—the need for munitions and army supplies. So acute was this need, so overpoweringly essential were the physical means for carrying on the war that David Lloyd George was transferred from his important post as head of the British Exchequer to the more important, newly created position of Minister of Munitions.

No other fact or event of the present great struggle emphasizes so strongly the part that the regulation of manufacturing plays in modern war; for when manufacturing control is put ahead of financial direction, the importance of the former has received super-emphasis.

Maj.-Gen. Leonard Wood also addressed the automobile engineers and their guests and drew an illuminating comparison between the army, with the organized forces of industry behind it, and the edge and the back of the blade of a cutting tool. He likened the army to the keen edge which meets and attacks whatever is to be cut or severed, is worn away in the process, perhaps even nicked and broken, and must constantly be renewed by repeated sharpenings. He then likened the stiff, strong, heavy back of the blade, which supports this keen cutting edge and makes its use possible, to the organized forces of industry behind the army. And he expressed keen gratification that the initial steps are being taken to organize American manufacturing and American engineers behind the United States Army. He also expressed the hope that we shall some day have an advisory board for the army doing the same work that is projected by the Naval Advisory Board.

When great reliance is placed upon an individual or an industry, an equal degree of responsibility goes with it. The army and the navy of the United States are relying upon the machine shops and other plants capable of producing war materials and supplies so to plan and organize their efforts as to provide all of the support that the cutting edge may need to be prepared to meet a possible national emergency.

If this plan is to meet a successful issue, it will mean not only hard work on the part of the military officials but painstaking and conscientious effort on the part of the American engineer and manufacturer. In the last analysis, the success or failure of the scheme of mobilization of American industry toward preparedness must find its solution in the detail endeavors of many thousands of individuals scattered throughout the country.

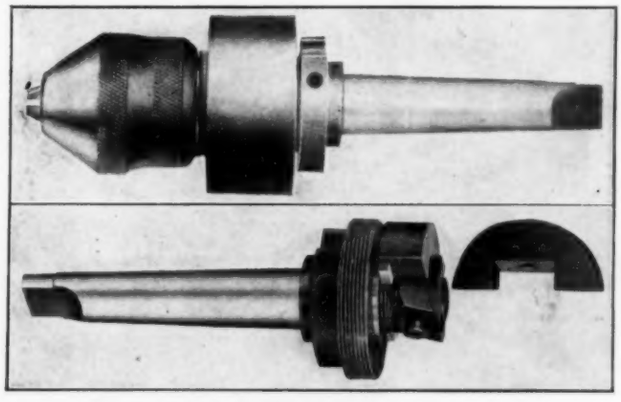
It is not enough to make careful plans; these must be backed up by the elaboration of detail so that every possible emergency is anticipated. Ways and means must be discovered to overcome the difficulties which experience has shown nations meet at such a time. American machine shops will not shirk the duty.

Shop Equipment News

Friction Tap Chuck

In the design of the tap chuck shown, compactness was the primary object, so as to permit convenient application to multiple-spindle drilling and tapping machines.

As indicated in the illustration, the tap is held to its work by friction. A disk of friction fiber is split in two and fitted around a beveled center piece. A chamber, just under the jaws of the chuck, goes over the split disk, and the halves of the disk are forced against the inner surfaces of the chamber by drawing the beveled center piece down toward the shank, forcing the halves apart. This friction grip may be tightened or loosened to suit



FRICTION TAP CHUCK

Capacity in range of five sizes, ⅛ to 1 in.; diameters of shanks, ½ to 1½ in.

any tapping job by turning the adjusting nut. No special tool is required for this, as a file, nail set or some other simple tool will answer the purpose.

The jaws of the chuck not only grip the round shank, but at their base hold the squared end also, thus minimizing the twisting strain.

This chuck is a recent product of the Bicknell-Thomas Co., Greenfield, Mass., and is made in five sizes with either straight or Morse taper shanks.

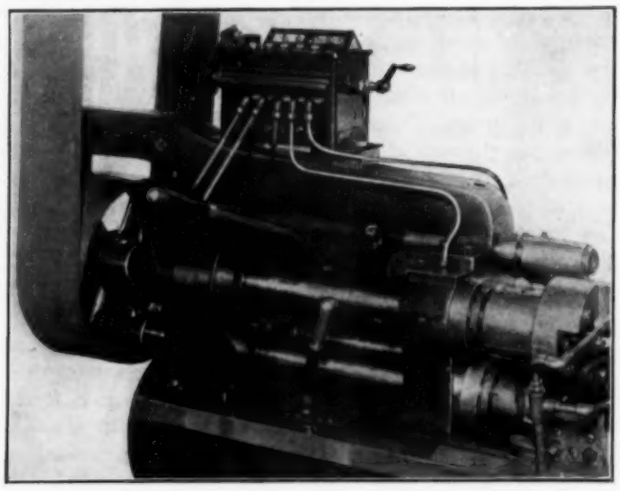
Valveless Force-Feed Machine Lubricator

The advantages claimed for the type of lubricator shown are that the supply of oil to each bearing can be exactly regulated to its requirements with no loss while the machine is at rest, only one receptacle instead of many to attend, and a positive supply that is not easily interrupted through any foreign substance.

The method of application is apparent from the illustration. All of the important parts of the lubricator are entirely visible. Each feed has its individual adjustment by means of the buttons placed conveniently on the top. The adjustment can be made either very fine or to pump several drops each stroke of the plunger, and it remains as set. The barrel is made of close-grained gray iron. Into the barrel is fitted a hardened-steel plunger finish-ground to an accurate fit, each barrel and plunger being thus individually fitted.

The barrel contains the ports and passages that are alternately opened and closed for the intake and discharge of oil by the rotating plunger. This action of the plunger renders the use of valves wholly unnecessary, and as it is positive, there is no "slip" or failure of the pump to deliver any oil that is fluid enough to be forced by atmospheric pressure through the suction passage in the barrel, which is straight and only ⅛ in. long.

The lubricators are furnished in either ratchet or belt drive. The lubricator delivers oil irrespective of the



FORCE-FEED MACHINE LUBRICATOR

Capacity, 6½ pints

direction in which the pulley turns. The reduction of the belt drive is 44 to 1.

The ratchet wheel and pawls have a face 1 in. wide and are made of steel. They operate constantly in oil, as do all the moving parts, which it will be observed are inside the tank.

The lubricator shown is made in a variety of sizes, in either single or multiple units, by the Madison-Kipp Lubricator Co., Madison, Wis.

Hydraulic Drawing Press for Forming Cylinders

The extreme pressure, varied conditions and hard service to which the casing of a Prest-O-Lite dissolved-acetylene cylinder is subjected demand that the cylinder be manufactured so that it will stand up well under such usage and have no leakage after the cylinder is filled and put in service. A seamless tube or shell was accepted as the best construction for the cylinder, and a hydraulic press, shown in Fig. 1, was designed and built by the Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, to meet the requirements.

The working speed of the main ram is sufficiently slow to do good work, while the auxiliary pullback cylinders are proportional so that the upward stroke of the main ram is approximately ten times the speed of its downward stroke. In this manner no time is lost by slowing up the actual drawing operation, but considerable time is gained on the complete operation. The press has a total pressure capacity of 800 tons and is of the inverted type, all of the cylinders being located in the head of the press. Between the movable platen and the base of the press a plain ring with babbitted bearings working on the strain rods is operated by two small side rams. This is called the blank holder, and during the initial drawing operation it grips and holds the disk of steel in place in the circular recess located in the lower and stationary platen of the press. The lower platen has through its center a hole which has a large recess at the top for receiving the female cupping dies through which the steel disk is forced. The press has two sets of auxiliary cylinders. One set returns the main pressure ram when the drawing or cutting operation is completed; the other set operates the blank holder which grips the steel disk as it is forced downward into the cup-forming die located in the die-ring holder of the lower platen. The two rams working from the side cylinders which operate the blank holder are 8¼ in. in diameter and have a run of 66 in. The main pressure ram has a diameter of 22 in. with a run of 78 in. The press has a working space of 78 in. The cylinder of the main ram which operates the movable platen to which the mandrel is attached and the cylinders of the two rams operating the blank holder are connected to the same pipe line.

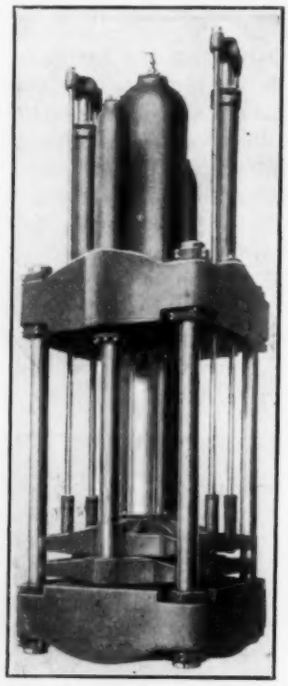


FIG. 1. HYDRAULIC DRAWING PRESS

FIG. 2. CUPPING OPERATIONS ON HYDRAULIC DRAWING PRESS

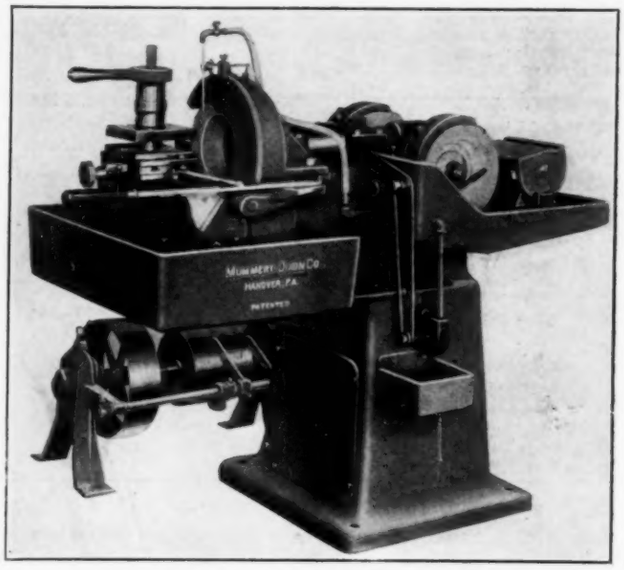
On this press are accomplished five complete cupping and drawing operations by which this plain steel disk, 42 in. in diameter, is reduced to a cup 17 in. in diameter and 25 in. deep. The first five cups, in Fig. 2, show the operations performed on the press. The remaining drawing operations are performed on a smaller press having a longer stroke of the ram.

Face and Tool Grinder

It will be observed that the machine shown is of the combination type designed for a double purpose.

On one end of the machine are mounted a coarse and a fine oilstone for stoning edge tools. The arbor carrying the two oilstone wheels is driven from the upper arbor through a set of hardened-steel spiral gears running in an oil-tight case. Ring oilers and phosphor-bronze bearings are used.

The other end of the machine is fitted with a face-grinding wheel for general work. Provisions are made for directing the oil through a suitable nozzle to this wheel, thereby keeping the work cool and the stone clean and sharp. The oil is caught by the pan under the table and returned to the oil reservoir. The vise is so constructed as to grip readily a wide variety of work. It is mounted on a slide that is moved back and forth by a hand lever on the slide table. The table can be adjusted and firmly clamped at any angle relative to the face of the grinding wheel.



OILSTONE FACE AND TOOL GRINDER

Drive pulley, 4 in. in diameter by 3½ in. face; 2 hp. is required; speed of upper and lower arbors, 1,200 r.p.m. Oilstones, 10x2-in. face, cupped; cylinder wheel, 10x3-in. face by 2 in. thick.

The work is fed to the wheel by a micrometer screw feed connected to the slide. The slide is provided with T-slots for fastening work when the vise is not used.

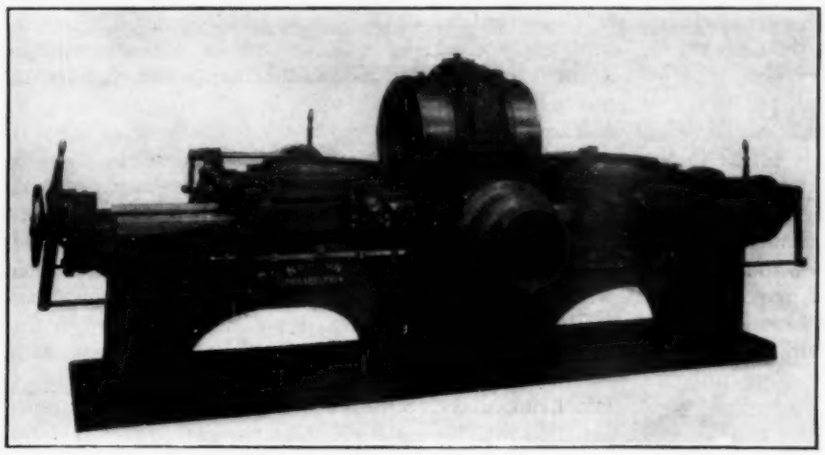
The machine is a recent product of the Mummert-Dixon Co., Hanover, Penn.

Special Boring, Turning and Facing Machine

Although the machine shown was specially designed by the Newton Machine Tool Works, Philadelphia, Penn., for boring, turning and facing a rear-axle automobile member, it is expected to be applicable to other classes of work.

The machine has individual cross and longitudinal saddle feeds, with positive turret feed stops giving four positions to the longitudinal and two positions to the crossfeed. The turrets have circular adjustment with six stations.

The spindle head carries a three-jaw universal chuck on each end. The drive to the spindle is through a large bronze spiral gear and hardened-steel pinions from a four-step cone. Power for all saddle motions is taken from the main pulley shaft through a gear-speed box having a 5 to 1 range and giving a change without removal of gears. All motions are independently clutched with hand levers, and release is effected by dogs on the saddles engaging stops. The turrets are accurately grooved to facilitate interchange of tool holders.



BORING, TURNING AND FACING MACHINE

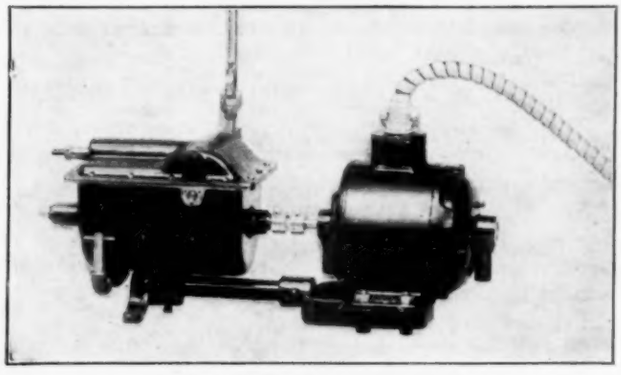
Internal chuck capacity, 12 in.; turrets, 18 in. diameter; maximum distance between centers, 16 ft. 6 in.

Other special classes of work for which this machine is particularly designed are the simultaneous trimming of closed ends and cutting excess length from open ends of shells up to 12 in. in diameter, and also contour-boring the interior.

Power and Speed Controller

The illustration shows a power- and speed-regulating controller recently developed by the Speed Controller Co., 257 William St., New York, N. Y. It is shown coupled to a $\frac{1}{12}$-hp. motor for motor control.

The device constitutes a complete machine in itself and is used for automatically limiting to, or reducing an excess of speed or power to, an exactly predetermined amount. It is centrifugal in action.



SPEED-CONTROLLING DEVICE

The centrifugal portion of the controller is essentially a high-speed governor of special design, in which the parts are quick-acting and sensitive to minute changes in speed. The transfer of power from the governor shaft to the secondary or indicating shaft is made directly and positively without waste of motion. The operating parts, being in continuous motion and in a state of exact balance, are ready at all times to respond to changes in velocity. Special means are provided to reduce friction in the centrifugal and other parts to extremely small amounts.

While sensitiveness and accuracy have been attained, the parts have been designed with a wide margin of safety as relates to their mechanical strength and durability.

This controller is also made in a double-acting type designed to perform its functions directly or to be used as a relay—operating an electric motor, an oil pump or other auxiliary device in overcoming heavy mechanical resistance. It is also adaptable to certain forms of remote control where its motor can be started and run continuously from the manual control point at three fixed speeds, at one of which the controller will be inactive at its adjusting shaft; at one higher speed it will produce motion in an attached apparatus in a certain direction, and at a lower speed the motion will be communicated in a reverse direction.

Heavy-Duty Cutting-Off Lathes

In the illustrations are shown two forms of high-speed heavy-duty cutting-off lathes especially designed for cutting off and facing shrapnel and high-explosive shells.

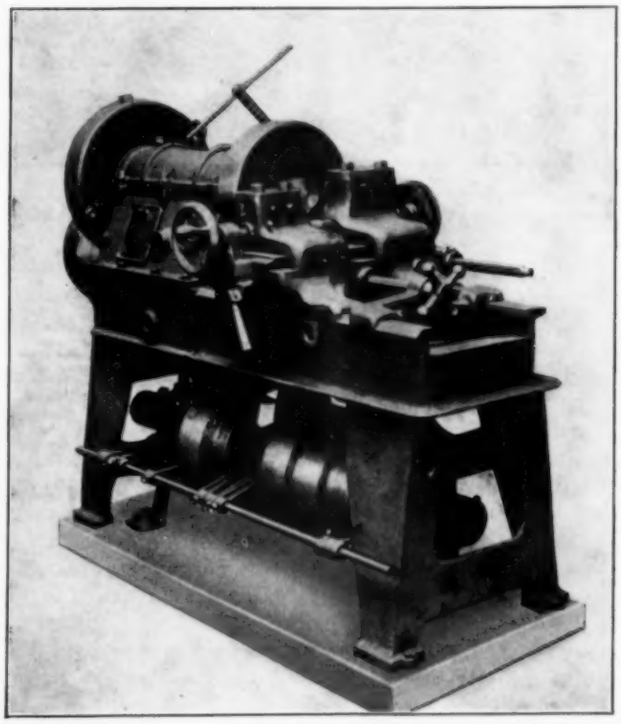


FIG. 1. SHELL CUTTING-OFF AND FACING LATHE

Capacity, 1½ to 3½ in.; speed of countershaft, 320 r.p.m.; diameter of tight and loose pulleys for 4-in. belt, 14 in.; motor, 3 hp.

The machine shown in Fig. 1 was designed for shrapnel shells. The general construction will be clear from the illustration, from which it will be observed that the design follows that of the pipe lathe.

The front part of the bed is cast with a solid bottom on an angle, which acts as a drip pan and catches all the cuttings, allowing the oil to drain off into the deep recess, from which it filters through to the oil well. The oil trough, around the outside edge of the bed, prevents any oil or cuttings dropping on the floor.

The spindle rests in a headstock that is bolted to the bed of the machine and doweled to prevent getting out of line. The spindle journals are of large diameter and wide face, fitted and scraped to an accurate bearing. The gears are of wide face, the ratio being 3¾ to 1, while the drive pinion is of steel. All gears are protected by gear covers.

The cone pulley at the rear of the machine is of large diameter, will take a 3½-in. belt and is supported on the outer end by a heavy bracket bearing. This provides

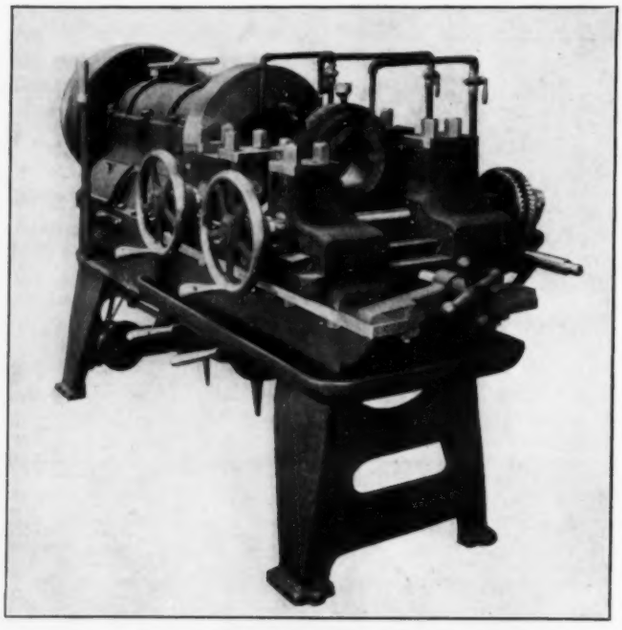


FIG. 2. HEAVY-DUTY CUTTING-OFF LATHE
Capacity, 6¼-in. stock; single-drive pulley, 16x6 in.; horsepower required, 25

three bearings for the drive shaft, which is only about 40 in. long, making a very compact and steady drive.

The chuck is of the universal self-centering type. The table is rigid, having long bearings on the bed, and is made gibbed so that it can be set and locked; or if a small amount of travel is required, it can be obtained by just leaving the carriage slack enough so that it can be moved forward, or backward, by operating the handwheel. In this way the whole cutting-off carriage and adjuster can be set and locked at any place required on the bed.

The cutting-off blocks are fitted on the carriage with a taper slide and gibbed, the rear block which takes the upward thrust having about 1½ in. more bearing than the front. In the front block is an adjuster bush which is screwed in or out by a pin wrench. This permits rapid adjustment of the tools to each other. The tool slots in the cut-off blocks are ¾x1½ in., so that either a tool holder or any size tool steel can be used.

The feed screw is $1\frac{7}{16}$ in. diameter and has a bearing at each end of the carriage. On the operating side there is a handwheel for quick return, and on the rear end of screw is a bronze wormwheel for the power feed. The crossfeed screw is protected by a sleeve to prevent cuttings from dropping on the screw where exposed between the blocks.

The operation of the power feed is controlled by the feed lever, which, by a third turn up or down, operates a small cam, under worm housing, which throws the worm into mesh, or vice versa.

The drive for the power feed is obtained from the main drive shaft, on which there is a three-step cone.

The machine shown in Fig. 2 is a triple cutting-off lathe especially designed for cutting up ingots for high-explosive shells. Similarity of design with the machine shown in Fig. 1 will be noticed. Increased rigidity is provided. The spindle, which is 9 in. in diameter with an 8- and a 7½-in. bearing, front and rear respectively, has four speeds. Two of these are obtained by clutch gears in the machine, which are operated by the lever at the operator's left hand, and two through the two-speed countershaft supplied with the machine. The power feed is gear driven direct from a large steel gear on the spindle, and the cutting speed can easily be increased or decreased by changing the gear on the feed shaft and adjusting the idle gear to suit. The clutches on the rear of the feed screw are operated by means of a fulcrum and lever handle, which passes right under the bed of the machine and comes up under each handwheel.

The machines shown represent recent additions to the line made by John H. Hall & Sons, Brantford, Canada.

Automobile Show of 1916

The sixteenth annual Automobile Show was held at the Grand Central Palace, New York, N. Y., on Dec. 31, 1915, to Jan. 8, 1916, inclusive. Over 90 different manufacturers of gasoline and electric vehicles had automobiles on exhibit, and over 250 makers of accessories also used show space. There were quite a number of motors partly cut away to show the construction of the cylinders, operation of the valves, path of the gases and other features of motor design, and the trend followed in design is worth noting.

One of the first noticeable facts is the lowering in price. A year ago the average price of the cars shown was over $2,000; this year it has dropped to $1,600. Most of the motors are now being made with block cylinders and unit power plants.

Increase in Number of Multi-Cylinder Motors

This year sees an epoch in multi-cylinder motor development. Eight- and twelve-cylinder motors are now quite common, and more sixes than fours are shown.

The wheel bases average slightly shorter than those exhibited at last year's show. The average S. A. E. horsepower rating is slightly lower, as the cylinder bores are smaller in diameter. The ratio, bore to stroke, is approximately the same as last year.

The speeds of the motors, however, have increased, this being made possible by the decrease in the weight of the parts; an increase in motor speed therefore develops an actual higher horsepower than recorded by the S. A. E. formula. The tires average smaller in diameter but larger in cross-section.

Left-hand steering and control are now used on over 85 per cent. of the cars, which is quite a noticeable change

from four years ago when only 25 per cent. were so equipped. The Franklin is now the only air-cooled automobile at the show. The selection type of gear set is used on over 90 per cent. of the cars, the friction drive getting more scarce than ever.

There are two important reasons—one apparent, the other obtained by investigation—to account for the marked decrease in the price of automobiles. It cannot be said that the cars are being made with either cheaper material or cheaper labor. The first reason is the reduction in the number of chassis models carried per motor. The automobile manufacturer has made a careful analysis and those models which were called for the least, or which did not give the highest satisfaction as regards service, have been dropped and the public is reaping the benefit.

The second reason is the advent of scientific handling of parts in the assembling departments—the result of similar thought to what was formerly exercised only in the machine shop to prevent lost motion.

A Few Special Features in Design

There were some rather novel systems of springs shown, including examples of rear transverse springing, where the two springs are different in length so that the upper, being the shorter, has a faster period of vibration than the lower. The effect is that the shock to the car is reduced. Another type of spring is mounted quite high and normally almost flat; another is a cantilever spring with the center clip well forward, these features being intended to produce an easier riding car.

The Fergus, a foreign car, has very distinctive lines and features. One is the provision for adjustment of the brakes; another is that the springs are inclosed in a pressure bath of oil. Simplicity of design and rigidity of the parts are apparent.

The Marmon has a distinctive feature in its aluminum motor, the pistons and cylinder castings being made of an aluminum alloy, and the cylinder bores fitted with linings of a harder metal. The body and gear set also show new features. The idea evidently of the entire automobile design is to reduce weight and still retain strength by the use of the lighter alloys.

Screw Machine Consolidation

The National-Acme Manufacturing Company has acquired the plant of the Windsor Machine Co. of Windsor, Vt. The present intention of the company is to continue at all three plants—Cleveland, Montreal and Windsor—along the lines heretofore followed.

For the purpose of providing funds for an extension at Cleveland about completed, for contemplated improvements at Montreal, and to provide in part for the purchase of the Windsor property, it is proposed to increase the capital stock of the company at a special stockholders' meeting called concurrently with the regular annual meeting to be held on January 20.

After All Machines Have Been Safeguarded wherever possible and tools have all been carefully inspected, there will still be the possibility of injury. Every foreman of a machine shop should call the attention of the operators or those under his direction to this possibility and encourage them in the practice of reporting unsafe conditions on machines or small tools. He should try to see to it that each one takes the necessary precautions to prevent injury to himself or a fellow-workman.

PERSONALS

Russell Huff, consulting engineer of Dodge Bros., was elected president of the Society of Automobile Engineers at its annual midwinter meeting in New York, Jan. 5.

Charles E. Blake, for many years associated with the Richardson-Phenix Co., Milwaukee, Wis., has been placed in charge of the company's recently established Boston office.

Paul R. Ketzer, formerly connected with the Watson-Stillman Co., has been appointed Eastern sales manager of the Metalwood Manufacturing Co., Detroit, Mich., with headquarters in Philadelphia, Penn.

J. W. Shepherdson has resigned as assistant general superintendent of the Central Iron and Steel Co., Harrisburg, Penn., in order to join the engineering division of the Morgan Construction Co., Worcester, Mass.

George Paterson, general superintendent John Goodison Thresher Co., Sarnia, Canada, has resigned, having accepted the position of general superintendent with the National Manufacturing Co., Brockville, Canada.

Martin G. Sperzel has resigned his position as sales engineer for the Standard Roller Bearing Co., Philadelphia, Penn., and has accepted a similar position with the Royersford Foundry and Machine Co., Royersford, Penn.

A. F. Blouin, for eight years ceramic engineer of the Abrasive Material Co., Philadelphia, Penn., and factory manager of the Cortland Wheel Co., Cortland, N. Y., for five years, has been appointed factory manager of the Springfield Grinding Co., Springfield, Mass.

OBITUARY

William Turner Lewis, second vice-president Mitchell-Lewis Motor Co., Racine, Wis., and one of its founders, died on Dec. 30, aged 75 years.

Carles Cooke Scaife, president of the William B. Scaife & Sons Co., Pittsburgh, died Dec. 30 at his home in that city, aged 72 years. Mr. Scaife was a native of Pittsburgh, and was identified with the business for over 50 years.

Ole N. Trooien, whose "steam-engine investigations" thesis, written at the University of Wisconsin in 1907, attracted international attention, and is now incorporated in engineering handbooks, died in Brookings, S. D., on Dec. 21, 1915. Mr. Trooien was in his thirty-fifth year.

BUSINESS ITEMS

The H. W. Caldwell & Son Co. has opened a sales and engineering office at 711 Main St., Dallas, Tex., in charge of J. C. Van Arsdell.

The Allied Machinery Co. of America, 55 Wall St., New York, announces a change of address by its Paris office. The Paris office and showrooms are now located at 19 Rue de Rocroy. The new quarters are in the vicinity of the Gare du Nord and in the center of the machinery district.

The Bullard Machine Tool Co., Bridgeport, Conn., is building a concrete and steel addition to its plant to cost about $100,000. It will be 268 ft. by 50 ft., first story having two crane sections, second and third stories to be machine rooms, and in the fourth story will be the main offices of the company, drawing room and shop executives' offices.

The Springfield Grinding Co. has been organized to manufacture a complete line of grinding wheels, with headquarters at Springfield, Mass., and factory at Chester, Mass., covering 100,000 sq.ft. of floor space. The plant is fully equipped and under the direction of Factory Manager A. F. Blouin, for eight years ceramic engineer of the Abrasive Material Co., Philadelphia, and for five years factory manager of the Cortland Wheel Co., Cortland, N. Y. The following are the directors and officers: Dwight O. Gilmore, president, is also president of the Hampden Savings Bank, Springfield, director of the Union Trust Co., Springfield, also director of the Chapman Valve Co., Indian Orchard, Mass.; A. D. Robinson, vice-president, and who will devote his whole time to the general management of the company; C. J. Wetsel, treasurer, is also treasurer of the Van Norman Machine Tool Co., Springfield, Mass., and until recently treasurer of the Baush Machine Tool Co., Springfield; Charles G. Gardner, secretary, is a member of the law firm of Gardner, Gardner & Stoddard, Springfield; Frank Page, director, is president of the National Equipment Co., Springfield, Mass., and president of the Van Norman Machine Tool Co., Springfield, is a director of the Springfield National Bank and is president of the Springfield Board of Trade. The product will be sold under the trade-mark of "Maxf."

Prices--Materials and Supplies

PIG IRON—Quotations were current as follows at the points and dates indicated:

	Jan. 7 1915	Dec. 10 1915	Jan. 7 1915
No. 2 Southern Foundry, Birmingham.	$15.00	$14.00	$ 9.50
No. 2 X Northern Foundry, New York	19.50	18.50	14.25
No. 2 Northern Foundry, Chicago	18.50	18.00	13.00
Bessemer, Pittsburgh	21.95	19.45	14.70
Basic Pittsburgh	18.95	18.45	13.45
No. 2X, Philadelphia	19.75	18.25	14.25
No. 2, Valley furnace	18.50	17.50	13.00
No. 2 Southern, Cincinnati	17.90	17.40	12.40
Basic Eastern Penn	19.50	18.00	13.50
Gray forge, Pittsburgh	18.45	17.95	13.45

MISCELLANEOUS METALS—NEW YORK

	Jan. 7, 1915	Dec. 10, 1915	Jan. 2, 1914
	Cents per pound		
Copper, electrolytic (carload lots)	24.00	19.75	13.25
Tin	41.00	37.25	33.25
Lead	5.90	5.25	3.80
Spelter	18.00	15.00	5.85
Copper sheets, base	30.00	25.00	18.50
Copper wire (carload lots)	30.00	28.25	14.25
Brass rods, base	35.00	27.25	13.00
Brass pipe, base	38.00	32.00	15.50
Brass sheets	35.00	27.25	13.25
Solder ½ and ¼ (case lots)	26.50	23.50	21.00

ST. LOUIS

Lead ..... 23.87½ Spelter 40.87½

MONEL METAL—The following prices hold:

Size, In.	Mill Lengths 8 Ft. and Over: 10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less than 500 Lb. of a Size and Over
Rounds—Squares	Cents per Pound				
⅛ — ¾	31.50	32.00	32.50	33.00	36.00
⅞ — 1⅛	31.25	31.75	32.25	32.75	35.75
1¼ to 1½	31.00	31.50	32.00	32.50	35.50
1⅝ to 2¼	31.75	32.25	32.75	33.25	36.25
Rounds					
3 to 3⅞	32.50	33.00	33.50	36.00	37.00
Squares					
3	32.50	33.00	33.50	36.00	37.00
Rounds					
3¼ to 3½	32.25	32.75	33.25	35.75	36.75
Squares					
3⅛ to 3½	32.25	32.75	33.25	35.75	36.75
Rounds—Squares					
4 to 4½	33.00	33.50	36.00	36.50	37.50
5 to 6½	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ⅛ in. thick.
Hexagon Bars two cents (2c) per pound over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

STANDARD PIPE—

	Discount: Black Jan. 7, 1916	Black Jan. 7, 1915	Galvanized Jan. 7, 1916	Galvanized Jan. 7, 1915
¾- to 2-in. steel butt welded	77%	81%	62½%	72½%
2½- to 6-in. steel lap welded	76%	80%	61½%	72½%

At the above discounts, the net prices follow:

Diameter, In.	Cents: Black Jan. 7, 1916	Black Jan. 7, 1915	Galvanized Jan. 7, 1916	Galvanized Jan. 7, 1915
¾	2.65	2.20	4.31	3.15
1	3.91	3.24	6.37	4.67
1¼	5.29	4.38	8.62	6.30
1½	6.33	5.25	10.31	7.55
2	8.51	7.05	13.88	10.15
2½	14.04	11.70	22.52	16.70
3	18.36	15.25	29.45	21.80
4	26.16	21.80	41.97	31.00
5	35.52	29.60	56.88	42.20
6	46.08	38.40	73.92	54.60

SAL SODA—The quotations below are per 100 lb. at the places designated:

New York	$1.00
Philadelphia	.75

ANTIMONY—For spot delivery on Chinese and Japanese brands, duty paid 43c. per lb. is asked.

STEEL SHEETS—

Black	Cents per Pound: Sheets from Warehouse, New York Jan. 7, 1916	Dec. 10, 1915	Jan. 8, 1915
No. 12	2.90	2.70	...
No. 14	3.00	2.80	...
No. 16	3.10	2.90	2.35
Nos. 18 and 20	3.15	2.95	2.40
Nos. 22 and 24	3.20	3.00	2.45
No. 26	3.25	3.05	2.50
No. 28	3.35	3.15	2.60
Galvanized			
No. 24	5.05	4.80	3.05
No. 26	5.20	4.95	3.20
No. 28	5.50	5.25	3.50

ZINC SHEETS—The following prices prevail:

Quantity	Cents per Lb.
Carload lots, f.o.b. mill	22.00
In casks, New York	25.00
Broken lots, New York	24.00

SEAMLESS DRAWN TUBING—As we go to press the base price is 35c. for brass and 35c. for copper. For immediate stock shipment 3c. is added, which gives the following quotations:

Diameter, In.	Cents per Pound: Copper Jan. 7, 1916	Copper Jan. 8, 1915	Brass Jan. 7, 1916	Brass Jan. 8, 1915
¾ to 2½	38.00	20.00	38.00	16.00
3	38.00	21.00	38.00	17.00
3½	39.00	21.50	39.50	17.50
4	40.00	22.00	40.50	18.00
4½	42.00	23.00	42.50	19.00
5	44.00	24.00	44.50	20.00
6	45.00	27.00	45.50	23.00
7	47.00	29.00	47.50	25.00
8	49.10	31.00	49.60	27.00

OLD METALS—The following are the dealers' purchasing prices in New York:

Copper	Cents per Pound: Jan. 7, 1916	Dec. 10, 1915	Jan. 8, 1915
Heavy and crucible	18.50	16.50	11.00
Heavy and wire	18.00	16.00	10.75
Light and bottoms	15.50	14.00	9.75
Lead			
Heavy	4.75	4.50	3.30
Tet	4.50	4.25	...
Brass			
Heavy	12.50	11.50	8.00
Light	10.00	9.50	6.75
No. 1 yellow rod turnings	12.50	12.00	...
No. 1 red turnings	12.00	11.00	...
Zinc	12.00	10.00	3.90

COKE—Below are the prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Dec. 18 1915	Dec. 25 1915	Jan. 1 1916	Jan. 8 1916
Prompt furnace	$2.50@3.00	$3.00@3.50	$3.00@3.50	$3.25@3.50
Prompt foundry	3.25@3.75	3.50@4.00	3.50@4.00	3.50

STEEL SHAPES FROM JOBBERS' WAREHOUSE, NEW YORK

	Jan. 7, 1915	Dec. 10, 1915	Jan. 9, 1914
	Cents per pound		
Steel angles base	2.50	2.40	1.90
Steel T's base	2.55	2.45	2.10
Machinery steel (bessemer)	2.50	2.40	2.05

The above prices are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger.

TURNBUCKLES—On sizes smaller than 1¼ in. diameter, 50% off list is charged, and on 1¼ up to 2 in. diameter 40%. At this rate prices follow:

Size	In.	Size	In.	Size	In.
⅜	$0.20	⅞	$0.375	1½	$0.90
7/16	.21	1	.44	1⅝	1.05
½	.225	1⅛	.50	1¾	1.20
9/16	.25	1¼	.75	1⅞	1.35
¾	.315	1⅜	.828	2	1.59

The above prices are for buckles having right and left stub ends and with openings between the heads emasuring 5½ in.

ROLL SULPHUR in 360-lb. bbl, sells in New York at $2.15 per 100 lb.

COTTON WASTE—In New York, the prices below hold:

	Cents per Pound
White	8.50@9.50
Colored mixed	6.50@8.00

COPPER BARS—The base price is 31c. per lb.

Three-Inch Russian Shrapnel--I

By John H. Van Deventer

SYNOPSIS—The accuracy and finish requirements of Russian field-artillery ammunition are more exacting than those of any other nation engaged in the present war. This article shows how American ingenuity has succesfully solved the problem of combining extreme accuracy with remarkably low production cost.

In the American plant which has done more than any other to make a success of Russian shrapnel manufacture there is an indicating gage fearfully and wonderfully made. It is of Russian design with two indicating needles the scales of which read to the ten-thousandth part of an inch. Stand with me a moment in front of the inspector's bench while the official in charge of this instrument tests a shell. Selecting one at random, he places it upon the two sets of rollers mounted in the base of the gage and then adjusts the indicating contacts upon the inner and outer shell surfaces. Watch the fluctuations of the indicating needles as he rotates the shrapnel slowly upon the rollers. Neither of the two needles swings quite one full division during the revolution. And one full division is one ten-thousandth part of an inch!

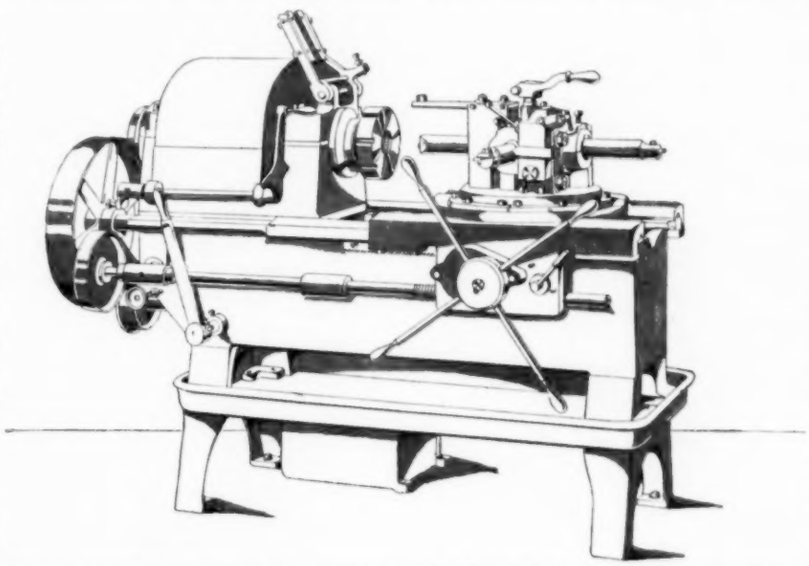


FIG. 1. SPECIAL-PURPOSE CHUCKING LATHE USED FOR SHELL OPERATIONS

Those of you who are familiar with the process of making the British 3-in. field shrapnel must forget the impressions you have gathered concerning this shell if you are to get an adequate conception of what it means to make an acceptable Russian shell of similar size. For while it is true that there is much similarity between the two in design and general construction, the details and the inspection requirements differ so widely that if Russian standards were to be applied to British shells now being made on this continent, fully nine-tenths of those which are passed as satisfactory would be decisively rejected.

This is not to be taken as a statement that the British requirements are too lax, or that on the other hand the Russian requirements are more strict than necessary. The final judgment in such matters, as is proper, rests with the ordnance officials of the nations involved, who must weigh the life of their field guns against the facilities for obtaining a plentiful ammunition supply. Also it must be remembered that the explosive charge and consequently the muzzle velocity of the Russian shell are considerably greater than the British, and that both of these factors have considerable bearing on the accuracy required in the shell.

The manufacturer who undertakes a shell contract faces a problem quite different from that which he encounters in his ordinary lines of work. He has a limited amount of business under control, with more or less likelihood of the initial order proving the final one also. The expenses of new machines, overhead items and all such charges must come out of the total amount received for the entire contract and leave something over for profit. It is a case involving very delicate judgment as to the cost of cutting corners. Investments which would be justifiable in the everyday work of an ordinary plant are out of the question on a limited contract. Keep this in mind as you follow the methods of manufacture outlined in this article, for it emphasizes the ingenuity displayed in keeping down the overhead investment without sacrificing the efficiency of the process as a whole. A minor problem, but one which requires care in the handling, is that of keeping the "heat lots" separate. Shell forgings are secured from a number of different manufacturers in lots which vary from 100 to 5,000 pieces. Each lot is quite likely to have carbon and other chemical contents slightly different from the others, although these are held between definite outside limits. In order that any defect in a finished shell may be traced to its source, the various shipments of rough shells as received in the plant are distinguished by lot numbers, which must be kept associated with these pieces during their progress through the plant. In addition to the heat-lot numbers, each shell has its own consecutive individual number, so that a check upon the total production is obtainable; this number, however, is not stamped upon the shell itself but appears only on the book accounts. This total count is mechanical and is obtained as the rough shells are conveyed into the plant.

Neglecting fine subdivisions, the various steps in producing a finished Russian shell at this plant are as follows: The forgings on receipt are given the continuous total count, heat lots are separated and counted and the shells are then cut off at both ends. This preliminary work is followed by rough-turning and inside finishing, after which come the heat-treating operations. After these come the outside base finishing and band grooving,

followed by either the base grinding or nosing, which, although consecutive operations, are often reversed in order to accommodate shop conditions. Next, the heat-lot number, which has been removed by machining, is stamped upon the finished base of the shell, which then goes to the chucking lathes to have its nose end threaded and formed. The body profile is next turned, followed by a filing and polishing operation, after which the shells are washed inside and out and delivered to the Government inspectors for the first inspection. This test is succeeded by inside painting, the diaphragm is next inserted and the copper bands are pressed on. The shells are loaded with bullets and smoke powder, the fuse cap is screwed in, the brass plug inserted and the spaces

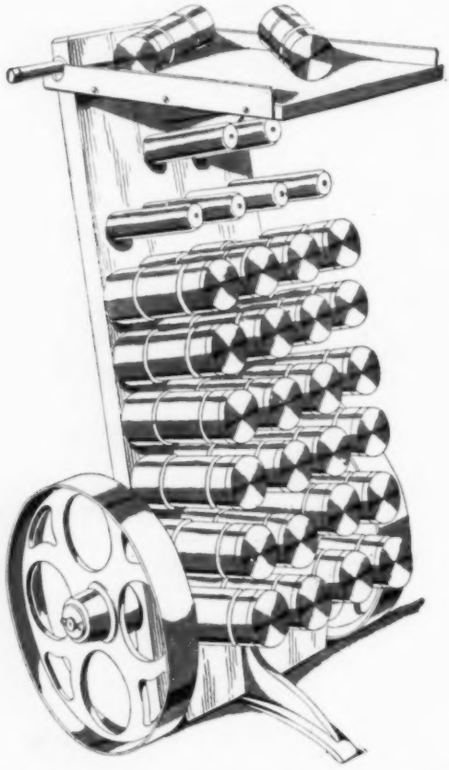
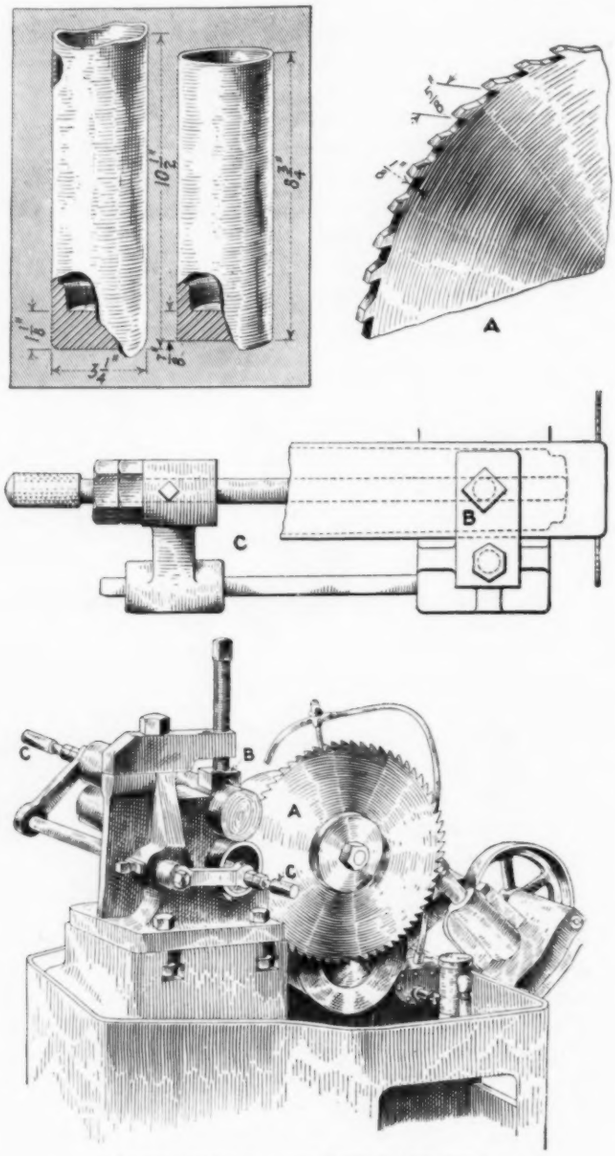


FIG. 2. PARTLY LOADED SHELL TRUCK WITH INSPECTION SHELF

between the lead balls filled with rosin, after which the standard weight is established. Next, the rosin filling-holes are plugged and riveted, and the shells go to a series of high-speed sensitive drill spindles which drill and tap for the cap-holding screws, which are then inserted and riveted over. The operation which follows is that of turning the copper band to its finished size and forming the nose end of the cap. This step is followed by nose filing and polishing, which is succeeded in turn by a final cleaning and the last Government inspection. The accepted shells are lacquered, the zinc plugs inserted and the shells boxed for shipment. Many of these operations, as will be noticed by following the operation sheets, are still further subdivided.

Specialized machinery has, since the outbreak of the war, done much to smash existing notions of what it is possible for metal-cutting machines to do. In this matter it is well to distinguish between two kinds of specialization—that which combines operations and results in more or less mechanical complexity, and that which isolates elementary operations and tends toward simplicity in both the machine and the operation performed. With either type of specialized machine it is quite possible to obtain the degree of accuracy required in a product such as the Russian shrapnel, but the gruelling punishment that is incident to obtaining day after day without interruption the production rates recorded in



OPERATION 1. CUT OFF BASE END

Machines Used—Cochrane-Bly No. 2-B saws.

Special Fixtures and Tools—15-in. saw blades A, ¼ in. thick, ⅝ in. pitch; regular-type holding-down block B; adaptation of regular length stop C.

Gages—None necessary after length stop is correctly set.

Production—20 to 25 per hr. per machine (on double-shell operation). One man can run 4 to 6 saws. Cut requires 3½ min.

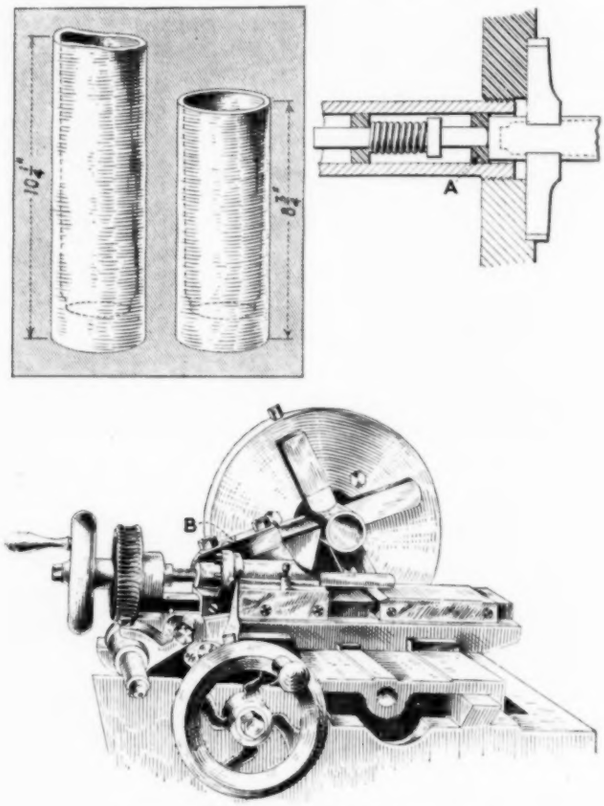
Note—Saws cut at 40 ft. per min. Blades require changing, on an average, every 7 hr. Cincinnati Bickford No. 10 automatic saw sharpener used for regrinding. Soap-water lubrication used. When run double, as shown, the succeeding operation is eliminated.

this article demands a specialization marked by simplicity, which is well typified in the special-purpose chucking lathe, shown in Fig. 1.

These machines, aside from what they have been and are accomplishing in the way of sustained high production, are notable in several respects. Some striking features are the method of driving these machines from a

floor shaft and the use of spring- and lever-actuated idler pulleys, which, by tightening or loosening the driving belt as desired, start and stop the machines without the need of clutches. These features, by eliminating stoppages for belt adjustment, are operating conveniences which also insures plenty of driving power at the spindle, while the unusually large spindle bearings and the low turret mounting provide rigidity for fast and heavy cutting.

Since one who is interested in following the making of the Russian shrapnel step by step may do so by referring to the operation sheets accompanying this article, it will not be necessary for me to duplicate these sheets



OPERATION 2. CUT OFF FUSE END

Machines Used—Hurlbut-Rogers 4-in. cutting-off machines.
Special Fixtures and Tools—Stop collar A in spindle for positioning shell, front cutting head B.
Gages—None.
Production—40 per hr. per machine. One operator to each machine. Cut requires 1 min.
Note—Cutting speed, 90 ft. per min. Front tool only is used. Feed (through belt and worm) approximates 0.003 in. per revolution.

with a full description of each operation in words. Therefore I will reserve the space available for text for pointing out and emphasizing the most interesting features of the process, somewhat as does a guide who accompanies a party through one of the Government department buildings in Washington. And just as many of the visitors there wander away from the guide to investigate things for themselves, so the reader may feel at liberty to leave the beaten path of text and wander about among the illustrations to his heart's content.

Previous to the war, finished Russian shrapnel were nickel plated. The need of an enormous number of shells in a short period of time suspended this requirement as far as American shops are concerned, although it still remains in the specifications. One not familiar with the reason might think it a high compliment to the possible enemies of a country to contemplate bombarding them with nickel-plated missiles, but finishing in this manner was intended as a protection against rust and not as an ornamentation.

American manufacturers have been able to persuade the Russian ordnance officials to permit the switching about of heat-treating operations so that these do not lead the sequence but follow the inside finishing and outside roughing operations, much to the benefit of the cutting tools. A curious thing was observed in one plant which had started with heat-treatment as the first operation on the rough shells and which later, as the result

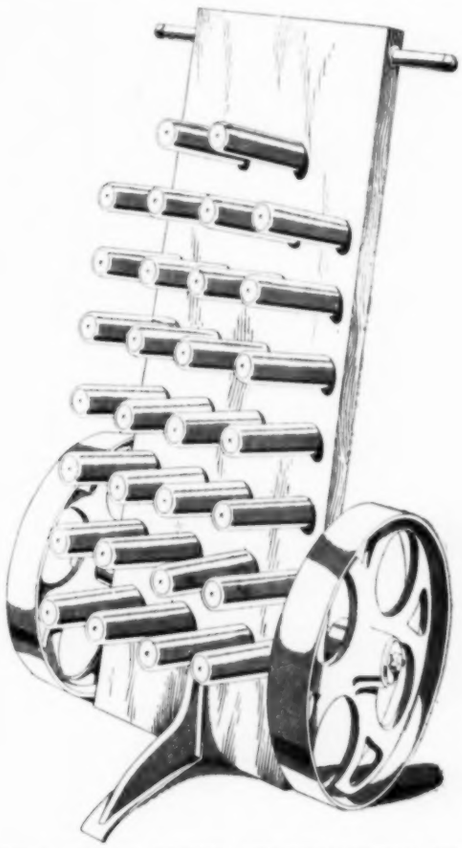


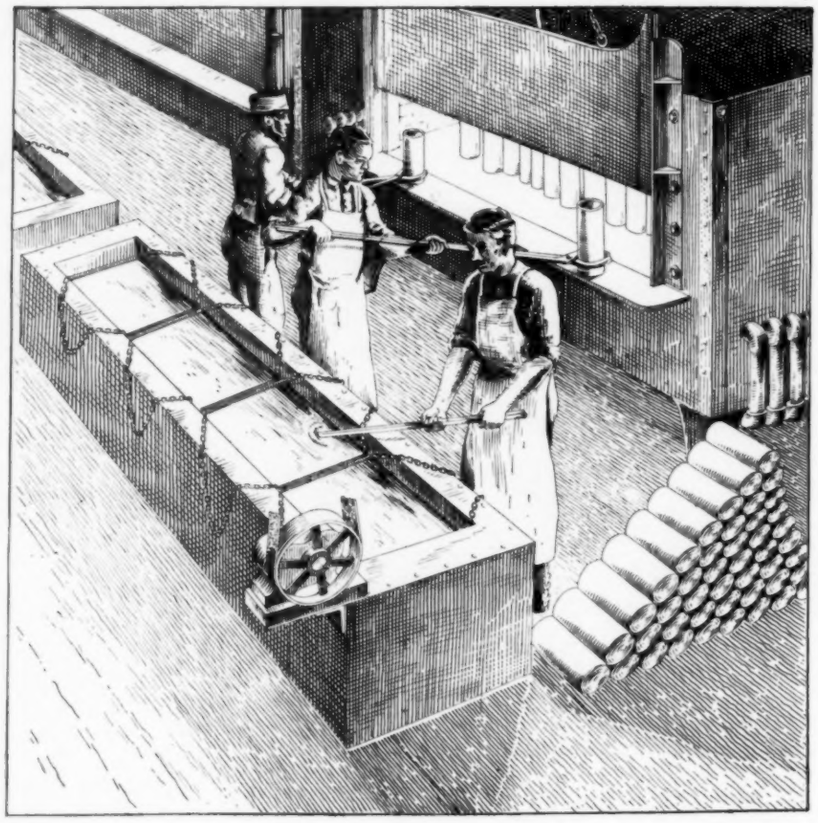
FIG. 3. EMPTY TRUCK, SHOWING SHELL PINS

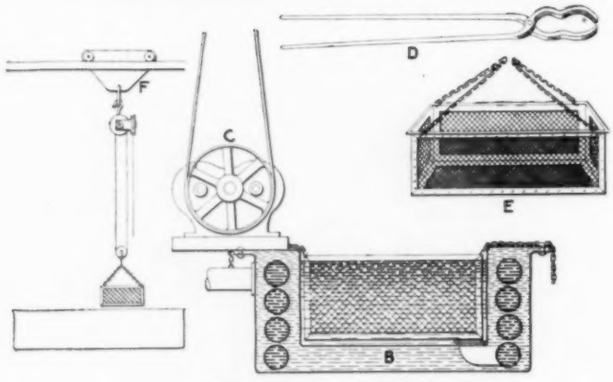
of excessive tool punishment, rearranged the sequence so that heat-treating follows the fourth machining operation. Formerly the capacity of heating furnaces and quenching tanks was taxed to keep up with the scheduled output. The removal of the forging skin by machining, although amounting in weight to not more than 15 per cent. of that of the rough shell itself, increased the capacity of the same number of furnaces and tanks over 30 per cent. In other words the outer skin of a steel forging has double the resistance to the conduction of heat than has the inner metal of the same piece.

The handling of several thousand shells as a daily output requires much study to prevent congestion, or more properly expressed, to balance successive operations. It is true that "dispatching" becomes a simple matter; in fact the necessity for it disappears altogether after the proper balance is once obtained. A shell shop is like a wood-planing mill in this respect, for an operator must keep up with the preceding machine or be buried under

the product. Floor space is too valuable to permit using it for storage space between machines. The transportation and inter-operation storage problems have both been solved by the use of special trucks, shown in Figs. 2 and 3, which with the addition of detachable top shelves, also serve as inter-machine inspection tables. The wooden pins of these trucks are so spaced that shells which are "bottled" may be laid between them, while shells in a condition previous to this operation are placed over the pins.

The problem of balance is naturally more difficult to solve for the hand operations than for machine operations. The first heat-treatment is a good example of careful planning to avoid lost motions. One furnaceman pulls the hot shells from the furnace interior with a pair of long shell-tongs, a man on either side of him taking the shell which he draws out and plunging it endwise into the oil-quenching tank. After one or two endwise motions to insure proper cooling, the shell is dropped into the tank, falling into a wire-mesh basket. The location of the quenching tanks with reference to the furnaces is so well chosen that the two quenchers need not move their positions, simply swinging their bodies as they transfer the hot shells from furnace to tank. After the entire batch has been pulled and while waiting for the next batch of shells in the adjoining furnace, the three men lift out the baskets and remove the hardened shells.





OPERATION 5. HARDEN

Machines Used—Equipment of Strong, Carlisle & Hammond No. 118 crude-oil fired muffle furnaces, blast from Root's positive blower; water-cooled oil-quenching tanks B; oil circulation supplied by rotary pump C.

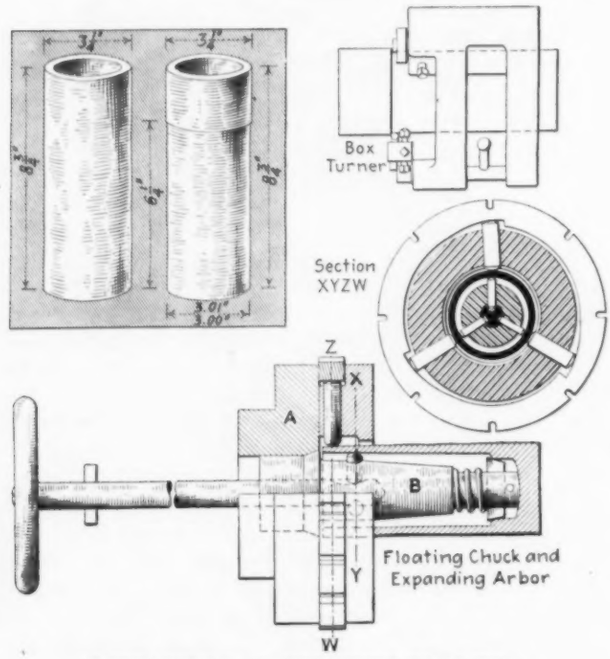
Special Fixtures and Tools—6- and 8-ft. shell tongs D, wire-mesh tank basket E, overhead trolley and hoist F.

Gages—None. Pyrometers to control furnace temperature.

Production—From each furnace, one batch of 50 shells every 35 to 45 min. Three men required to handle each heat. One man pulls out the heated shells with the long tongs while the other two dip them.

Note—Furnace temperature maintained at 1,420 deg. F.

Reference—Heating furnace, illustrated in Fig. 4.



OPERATION 3. ROUGH-TURN BASE END

Machines Used—Special-purpose chucking lathes.

Special Fixtures and Tools—Floating shell chuck A, internal expanding arbor B, roller back-rest box turning-tool C.

Gages—Go and not go snap gage; limits, 3 to 3.01 in.

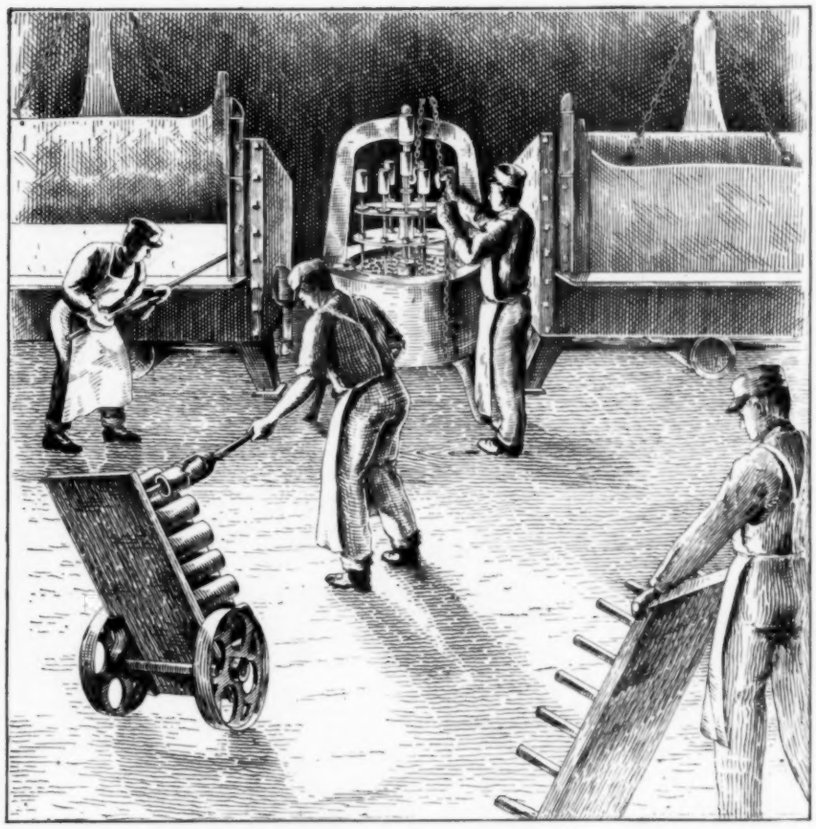
Production—From 25 to 30 per hr. from one machine and one operator.

Note—Cutting speed, 75 to 90 per min.; feed, ¼ in. Cut requires ¾ min. Soap-water lubrication used. The forging is located in chucking position by the interior mandrel and then gripped by the floating chuck pins as an additional drive.

Reference—Chucking lathe, shown in Fig. 1.

The shells after coming from their heat-treatment are neither sand-blasted nor pickled, it having been found that these processes are unnecessary. The inside surfaces of the shells do not scale appreciably, due to the fact that the air within them is not in circulation, and in fact the exterior of the shells is remarkably free from scale also, due to quick handling between furnace and oil bath.

Remarkably fast forming of tough heat-treated material is being done in the seventh operation. The cut,



OPERATION 6. DRAW

Machines Used—Equipment of two Strong, Carlisle & Hammond No. 118 oil-fired muffle preheating furnaces and one Frankfort No. 2 crude-oil fired lead pot.

Special Fixtures and Tools—Eight-spindle shell crib attached to melting pot.

Gages—Scleroscope hardness tester. Hardness ranges from 40 to 46.

Production—From one pot, using alternate preheating furnaces, three men draw 2,500 shells per day of 10 hr. One man takes shells from preheating furnaces, placing them in the pot. The second man operates the hoist and turns the crib. The third man takes shells from the pot and places them on the truck. An additional man is required to operate the scleroscope, and one man (the foreman) regulates temperatures and sees that trucks keep moving.

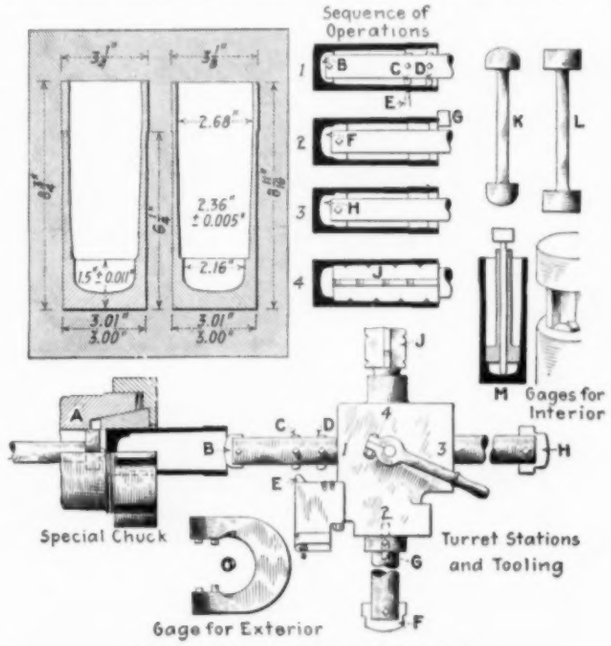
Note—The preheating furnaces heat the shells to 940 deg. F. The lead pot raises this to the drawing point, 1,040 deg. F.

which is over 2 in. wide, is taken at a cutting speed of 75 ft. per min.; and under this hard usage the tool, by careful handling, will stand a day's run without regrinding. Another interesting example of forming will be shown in the fifth suboperation of operation sheet 10, in which the nose-forming tool *H* roughs off the nose profile. This, however, is not altogether a forming operation, the tool being fed parallel with the axis of the shell until the full reduction in size is reached.

This operation was formerly divided into two parts with the purpose of putting less strain on the forming tools and thus securing longer service from them. Under this procedure, the base end was first rough formed to within 10 thousandths in. of finished size leaving the removal of this amount of metal together with the knurling and undercutting for the second half of the operation. Experience has shown, however, that the additional chucking and handling time offset the wear on the forming cutter and as a result, the two operations were combined into one, and are now performed as here described. This is an illustration of the fact that the best way to do a certain thing can be determined only by trying it out, and letting experience dictate the answer.

If there is or ever has been a more industrious lead pot than the one shown in Fig. 4, it has not as yet been recorded in history. This one easily takes care of drawing the temper of 2,500 shells in 10 hr. It is true that the shells are preheated to within 100 deg. of the drawing temperature in an oil-fired muffle furnace, but even with this assistance this lead pot is a very busy appliance. It also illustrates another example of nicely timed handwork. The perspective illustration of operation 6 shows one man at the pot, whose duty it is to rotate the shell-holding fixture and to raise and lower the weighted spindles by means of a hook attached to a tackle block. It is rather strange to see the shell rise to follow the lifted spindle and makes one look for some magnetic device until he remembers that steel will float on melted lead. The man standing in front of the furnace at the left takes the preheated shells from it and places them one at a time under the spindle which has been made vacant by the man in the center who removes the shells from the pot and places them upon the pins of the special trucks upon which they are allowed to cool.

The same difficulty that is encountered with entrapped air in thrusting an inverted glass tumbler into water is



OPERATION 4. BORE AND REAM

Machines Used—Special-purpose chucking lathes.

Special Fixtures and Tools—Special shell chuck A. Cutting tools: 1—Powder-pocket roughing cutter B, roughing cutters C and D for reamer, outside turning tool E. 2—Rough step cutter F for powder pocket and diaphragm seat, facing tool G. 3—Finishing step cutter H for powder pocket and diaphragm seat. 4—Reamer J.

Gages—Double-end limit plug gage K for diameter of powder pocket, double-end limit plug gage L for diameter of diaphragm seat, special limit gage M for depth of powder pocket, snap gage O for diameter of open end.

Production—12 per hr. from one machine and one operator.

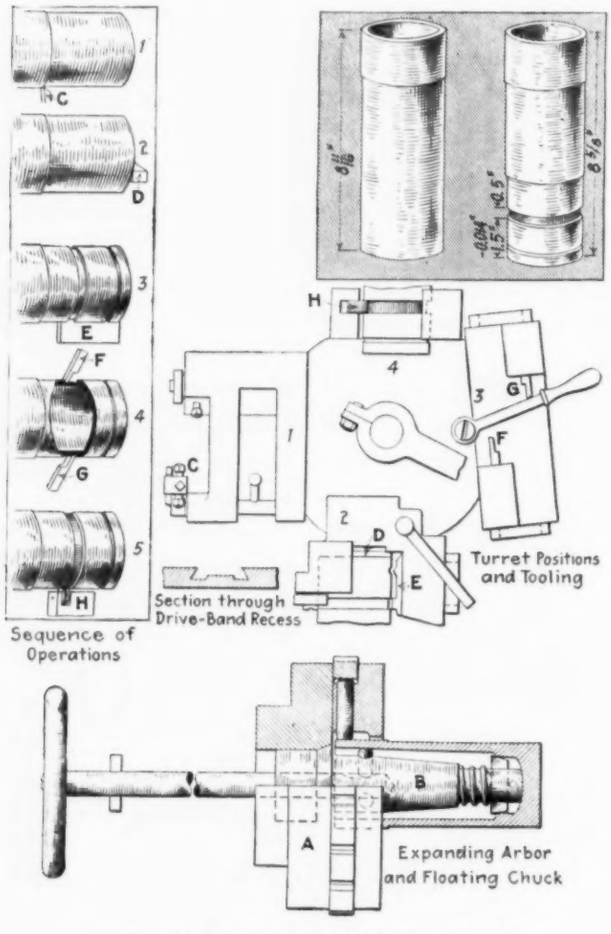
Note—Cutting speed, 70 ft. per min. Hand feed used on all suboperations except No. 1. Reaming speed, 45 ft. per min.

Reference—Chucking lathe, shown in Fig. 1.

encountered when an inverted shell is thrust into a lead pot. This trouble has been very cleverly overcome by the siphon device shown on the operation sheet, which acts not only as a support for the inverted shell but also as a means of venting the entrapped air.

From the manufacturer's standpoint, aside from its close limits, the Russian shell presents many difficulties which are avoided in the British shrapnel, as will be evident when we arrive at the description of the loading operations. It has one feature, however, which goes a long way toward offsetting these, in that the diameter of the hole in the finished shell nose is large enough to admit a bar with a cutter that is the full size of the finished powder pocket. This means that it is possible not only to finish bore the shell before heat-treatment, but also to correct that portion of the product that shrinks in heat-treatment and in which the powder-pocket diameter and disk seat come under the minimum limit.

You will notice that in the process outlined the shell is finished all over, inside and out, unlike the British shell, in which considerable of the rough-forging skin is left in the interior. This difference is not because of the insistence of the Russian specifications on this point, but because it is difficult to maintain the close limits required unless the finishing is done. However, this seeming drawback has been in a way made to serve as an advantage, for the inside finishing has been so carefully planned in connection with the nose bottling that it is unnecessary to finish the inside contour of the nose after the shell is closed in, as is required in the British shell.


Sequence of Operations
Section through Drive-Band Recess
Turret Positions and Tooling
Expanding Arbor and Floating Chuck

OPERATION 7. FINISH FORM BASE END

Machines Used—Special-purpose chucking lathes.

Special Fixtures and Tools—Special floating chuck A, hand-wheel-operated expanding arbor B for gripping internally.

Cutting Tools—1—Roller-back-rest turner C. 2—End-facing tool D, groove-forming tool E. 3—Recess undercutting tools F and G. 4—Knurling tool H.

Gages—Limit snap gages for diameters of base and groove, limit templet gage for undercut and location of groove from base.

Production—From one machine and one operator, 12 per hr. Cutting speed, 75 ft. per min. Hand-lever longitudinal and cross-slide feeds.

Note—Soap-water lubrication used. This operation brings the base end of shell to a finish. The forming tool E by careful handling will stand a day's run. The end-facing tool D is operated in connection with the crossfeed on tool E for cutting to the center of the shell.

Reference—Special-purpose lathe, shown in Fig. 1.

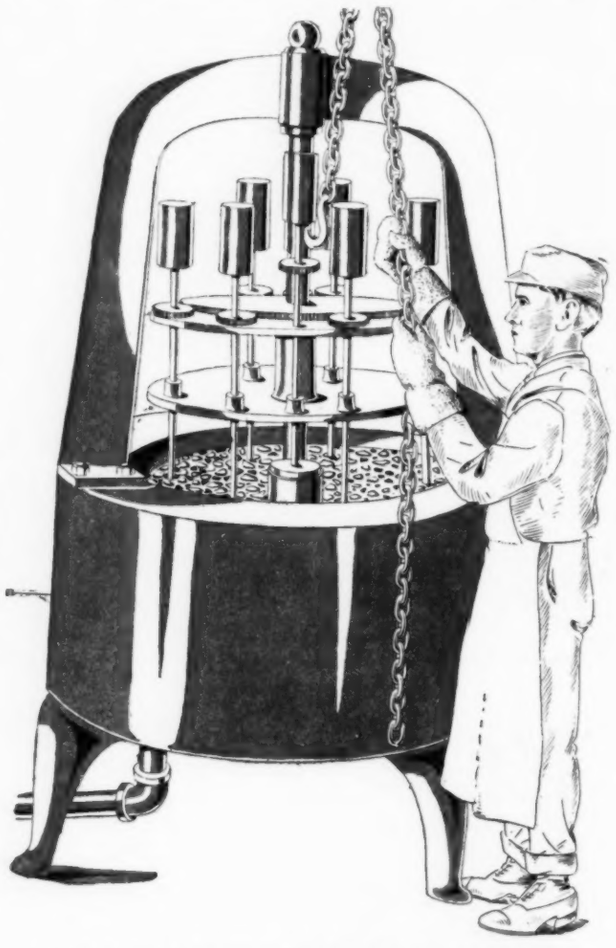


FIG. 4. THIS LEAD POT IS A BUSY APPLIANCE

Prompt Replies to Inquiries

By H. R. Gilliam

A feature of good service which, if appreciated, is not practiced as generally as it might be, is the prompt reply which should be made to unsolicited inquiries.

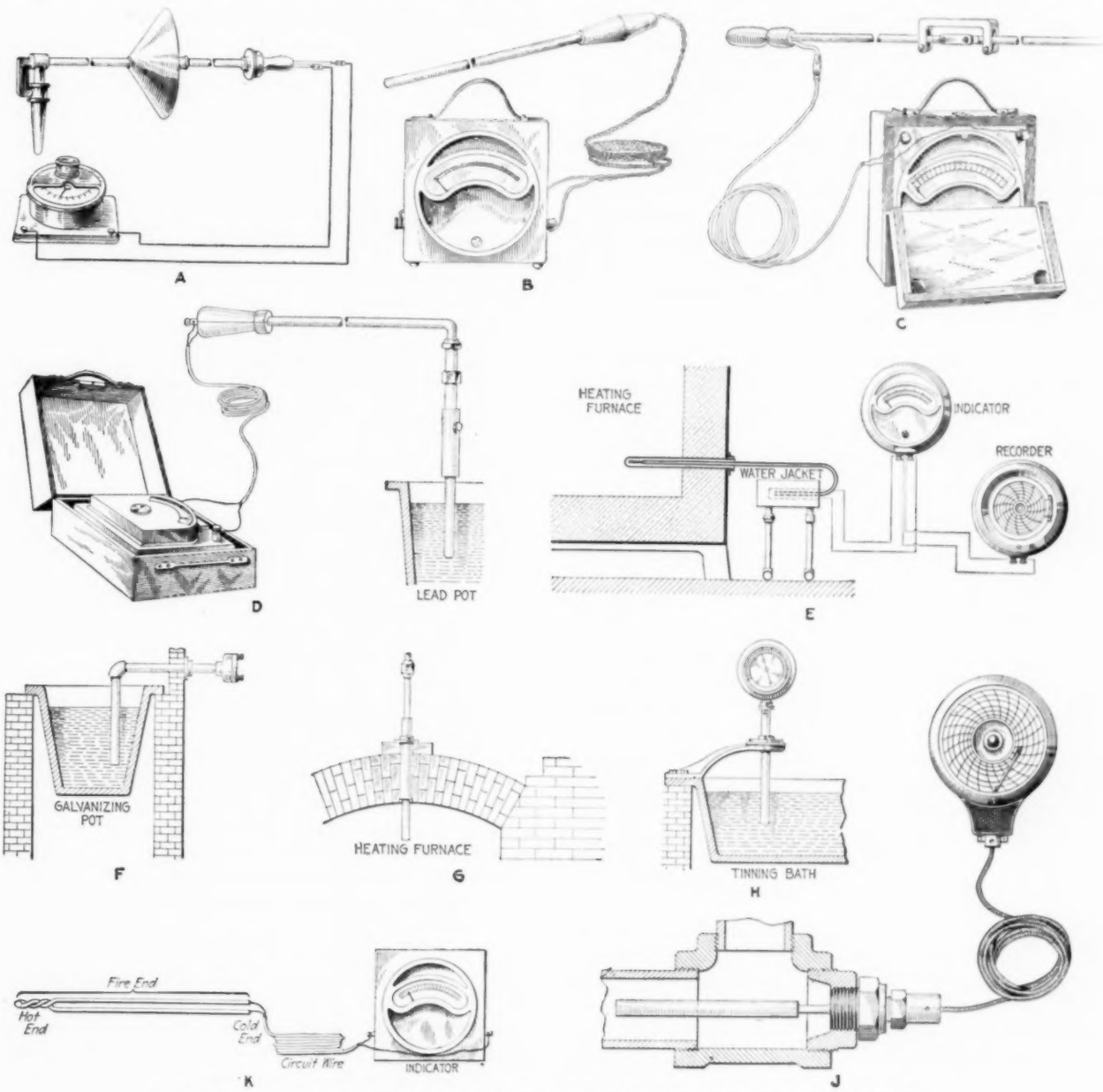
A certain concern suddenly found itself in need of a machine, and inquiry was made of two manufacturers for circulars and description. One of the manufacturers came back promptly with literature, prices and all necessary information. The need being urgent and the machine seeming to meet the requirements, the order was placed after short consideration. But much to the buyer's chagrin, when the reply eventually came from the other manufacturer it was found that the second machine came nearer the requirements than the first and would undoubtedly have been purchased had it been possible to have both machines under consideration.

Taking Small-Shop Temperatures

By John H. Van Deventer

SYNOPSIS—The small-shop man is not interested in abstract theories. But if an appliance, tool or instrument will help him make more money or produce a better product, he wants it. This article deals with pyrometers from the small-shop users' viewpoint.

Why does an Indian decorate himself with feathers and war paint, a doctor write prescriptions in hog Latin, and a scientist cover up a new grain of knowledge with a name that has been dead and buried for ten thousand years? Not because any one of these individuals has a grudge against the small-shop owner, but because each is instinctively following one of the three inherited principles of the preservation of prestige. The Indian is putting up a physical bluff—decorating his body so that he will appear imposing. The scientist is putting up a mental bluff—decorating his discovery with a name that will be hard for common people to pronounce and understand. The doctor is not bluffing at all—he is just keeping business in the family, and the worst part of it is that all three of these fellows get away with it!



VARIOUS TYPES OF PYROMETERS SUITABLE FOR USE IN THE SMALL SHOP

A—Le Chatelier portable thermocouple pyrometer. B—Hoskins portable pyrometer. C—Bristol portable thermocouple pyrometer. D—Englehard portable bent mounting for lead pots, etc. E—Hoskins base-metal thermocouple with indicator and recorder and water-cooled cold end. F—Brown base-metal thermocouple with bent mounting. G—Le Chatelier rare-metal fire end mounted in arch of heating furnace. H—Brown expansion pyrometer mounted in tinning bath. J—Bristol gas-expansion recording thermometer mounted for temperatures of fluid under pressure.

I believe that a man who invents a new machine or appliance and then goes back to the Dark Ages to find a name for it is unconsciously handicapping its sale and use. The name conveys the impression that the thing itself is highly scientific and thus erects a barrier of exclusiveness. Of course if it is something that people need, the demand for it will in time overcome the handicap of the name, which will become familiar; but nevertheless the handicap exists at first and is an unnecessary one. Take, for example, tachymeters, scleroscopes and pyrometers—one of a bashful and retiring disposition might hesitate to make the acquaintance of such high brows, whereas he would be glad to shake hands with a "speed gage," "hardness tester" and "heat gage."

This may be one reason why the measurement of temperatures in small shops is not as thoroughly understood as it should be. It takes time for instruments which originate in the laboratory to filter down to the level of small-shop practicability. But I venture to predict that 20 years from now the pyrometer will be as familiar and well understood a small-shop tool as is the micrometer at the present day.

Twenty years ago a micrometer was seldom found in a small shop. Nowadays you seldom find a small shop without one. Progress has made it necessary to work to close limits of size, and the use of proper size-measuring instruments followed this as a natural result. With later progress has come the refinement of materials which calls for some means to measure temperature as the micrometer measures diameter.

Old Man Jones, of Lancaster—an Optimist

Old Man Jones, of Lancaster, took a contract for some machines, among the parts of which were a number of nickel-steel heat-treated gears. He never had handled any alloy-steel work in the past, but had a blacksmith who was a crackerjack at hardening springs and cutting tools. Jones, being a progressive chap, determined to meet and get acquainted with the alloy-steel proposition, as he could see considerable business for one able to handle it. After careful machining, the gears were handed over to the blacksmith for heat-treatment. This gentleman was not as optimistic on the subject as Old Man Jones but said that he would do the best he could. The heat-treatment specified was to heat these gears to 1,550 deg., quench, reheat to 1,350, quench, and reheat to 800 deg., after which they were to be slowly cooled.

The first act of the worthy smith was to look up a color chart and translate the heat-treatment temperatures into colors instead of degrees. He found that 1,550 deg. F. represented a medium cherry red, 1,350 a dark red, and 800 deg. the lowest visible red. It was really as easy as matching shades of silk in a dry-goods store without the samples!

The furnace was a small one, and as a result the job had to be divided into several batches which were separately heated. When they were finished, the gears all looked much alike except that some had a little more scale than others. They rang the same when tapped with a hammer and seemed to give the same amount of pull upon a smooth file.

Old Man Jones and his blacksmith tried almost everything they could think of to test those gears, except biting a piece out of each of them. They were sure that they had a good job, but the customer's inspector did not seem willing to take their view of the matter. He put the gears under a strange-looking instrument that was a cross between a thermometer and an atomizer and declared that twenty-three out of thirty-five would not pass the required hardness test.

"Why don't you fellows get a pyrometer and know what you are about?" he asked Old Man Jones. Then being a decent sort of chap and seeing that he might as well have asked Jones why he did not keep an ichthyosaurus in his backyard, he explained what a simple instrument a pyrometer really is.

"What you need in your shop is a thermocouple pyrometer," said the inspector, "which is nothing more than a couple of wires running from an indicator and joined together within the furnace. When the joined end of the wires is heated, you look at the indicator and read off the temperature. The thing is really as simple as a thermometer and a good deal easier to read."

Various Pyrometers and an Irishman

There are a number of kinds of pyrometers besides those made on the thermocouple principle. Some depend on the pressure exerted by a gas inclosed in a tube. There is an accurate type known as the "resistance pyrometer," which is a bit too complex for the average small shop. There are radiation and optical pyrometers which look like telescopes and are simply pointed at the hot objects. They are most suitable for work above 3,000 deg. F., for no part of the apparatus itself is heated.

The instrument shown at *H* in the illustration is an "expansion pyrometer." It works on the difference of expansion of graphite and iron rods in its stem, and its upper working limit is 1,500 deg. F. I recall an experience with one of these instruments and with an Irishman named Pat, who was engaged to run the galvanizing department of a large upstate machine shop. The management of this plant had decided to have everything up to date and so got a pyrometer for Pat, without knowing that his education had not gone as far as reading either words or numbers. Pat, however, was too foxy an individual to give this fact away. Suspecting it and wishing to have a little fun with him, I asked him one day what temperature he was carrying on the galvanizing pot. Quick as a flash the answer came back, "Sure you have got spectakils on; you can see it twice as aisy as me!"

The thermocouple pyrometer, which is the one for the small shop, is made in a great variety of styles and in two general classes, portable and permanent. The first kind, as the name indicates, can be carried about from place to place and used to take the temperature of almost anything in the shop except a feverish haste. The second kind is installed in a lead pot, heating or annealing furnace or other place where it is desired to keep a continual check on temperatures.

What Constitutes a Thermocouple Pyrometer

The parts comprising a base-metal thermocouple pyrometer are shown in the illustration at *K*. The arrangement does not look formidable, and indeed it is about as simple an instrument as could be devised. It consists of a couple of wires of unlike material which are twisted and welded together at one end. At the other end they are connected through an electric-wire circuit with a simple indicating instrument exactly similar to a voltmeter, except that it registers degrees

of temperatures instead of volts. When the welded end of the couple is heated, an electric current is set up by which the degree of heat may be measured. Fire ends are of two general kinds. One kind is known as the "rare metal" thermocouple and is used for the high temperatures between 1,800 and 3,000 deg. F. The other kind is known as the "base metal" thermocouple and is made of more common and less expensive material, which, however, will not do for continuous service over 2,000 deg. F.

The fire ends of thermocouple pyrometers are protected by sheaths of various materials, according to the service and the degree of heat. Porcelain tubes are used for the highest temperatures. In a lead bath an iron sheath or seamless-steel tube is used with a nickel-plated envelope above the surface of the metal to protect against vapors. Firebrick tubes are sometimes used for annealing furnaces, and graphite or clay tubes are used for measuring melted-metal temperatures. The protecting tubes should project into the furnace or the melted metal at least six inches.

At the Other End of the Wires

Two kinds of instruments are connected to the fire ends of either of the foregoing types—indicators, which indicate temperature, and recorders, which make a continuous graphical record similar to that made by a recording pressure gage or recording wattmeter. An instrument of each kind may be attached to the same fire end and will register its temperature simultaneously, one indicating and the other recording. Again a number of fire ends in various furnaces may be attached to the same indicator and recorder by means of suitable switches, so that one fire end at a time can be switched on the instrument, thus letting it take care of several furnaces, but of course only one at a time. Usually the indicator is placed so as to be easily seen by the furnace tender; while the recorder, which is a more delicate and expensive instrument, is mounted in the office or in a protecting cabinet.

The average small-shop man can get along without the recorder. A good base-metal indicating outfit can be bought for from $25 to $50. Additional base-metal fire ends will cost from $3 to $8 each. Rare-metal fire ends are four or five times as expensive. Fortunately, for most shop use the base-metal fire end will serve, leaving the more expensive kind for the foundry, which can quickly make up its cost by rapping the patterns a little harder!

Making the Shop Pyrometer Behave

Even the ordinary mercury thermometer, on which we base our opinions of the climate, is likely to err. So it must not be supposed that a pyrometer, which is subject to such a high limit of temperature, will do its work day after day without attention. Portable pyrometers which are used occasionally do not change very quickly, but those which are subject to constant heat must be looked after at regular intervals.

Nine times out of ten when there is anything the matter with a pyrometer, it is in the fire end. It may be due to a faulty connection at the end of the couple where the instrument leads are attached, or to too hot a "cold end," but it is much more apt to be because heat and gases have affected the "hot end."

The prices of base-metal fire ends are so reasonable that the small-shop man can afford to have a half-dozen of them in stock, keeping one as a reference with which to check up the accuracy of those which are in daily use. Checking consists simply in connecting the two fire ends to the same source of heat and to the same indicator with a double-throw switch on the circuit so that alternate readings may be taken on each fire end with the same indicator. Of course the readings should be the same; but if there is any difference, the correction can be made. Fire ends which are in constant use at a temperature of 1,500 deg. F. should be tested once a week, and those which are subject to a constant temperature of over 1,500 deg. should be tested daily if accurate readings are desired. If out over 20 deg., the fire end should be annealed from one to five hours at a temperature of 1,472 deg. and then retested.

Another way of checking up thermocouple pyrometers is by the use of what are called "sentinel pyrometers." These are small cylinders approximately ½ by ¾ in. which melt at different temperatures ranging from 400 to 2,400 deg. F. Below 932 deg. they are inclosed in glass tubes so that they may be used over and over again. The higher-temperature sentinels are set in porcelain saucers and are also used repeatedly, being caught in the saucer when melted. Placing a number of these in the furnace with the pyrometer, watching when they melt and noting the indicator reading at the same time will give a very good check on the accuracy of the pyrometer.

There are other methods of checking thermocouple pyrometers, one of them being by the melting or freezing points of metals such as tin, lead, zinc, aluminum, salt and copper; however, for the small shop the sentinel pyrometers are more convenient and likely to give more accurate results.

Taking Care of the Cold End

The amount of current flowing is determined by the difference in the temperature between the hot end and the cold end, which latter is kept at a certain average temperature, or else corrections are made for any differences in temperature above or below that for which the cold end is set. There are various ways of taking care of the cold end of a thermocouple pyrometer. One of these, practiced by the Bristol Co., is to make the thermocouple element long enough so that the cold end is extended outside of the furnace down near the floor level, where the temperature does not vary a great deal. The Hoskins Co. in some cases recommends the use of a water-cooled cold end, and instruments of other concerns provide a compensator for adjusting for differences of temperature at the indicator. A fairly good way is to bury the cold end under ground. Don't have it where a draft of cold air is likely to blow on it. Don't locate it so that heat from the furnace or melting pot will be able to affect its temperature. A little care about these things will save "cuss" words later on.

The small-shop man who uses the same amount of intelligence with his pyrometer that he does with his micrometer will find it the means of getting uniform heat results which will better his product. He will not have much trouble keeping the appliance in good workng shape. He will find it accurate, reliable and long-lived—unless he does as they tell of one pyrometer purchaser, who stuck the indicator in the furnace and tried to get the fire-end sheath off so he could read the "dommed thaymometer" inside!

Machining Parts of Eight V-Motor

By Robert Mawson

SYNOPSIS—The operations include milling, drilling, reaming and boring. The parts are the cam-gear housing, cylinder cover and cylinder head. The milling fixture for the head holds two castings, one for machining the upper, and the other the lower surface.

On page 14 were shown some of the tools used in machining the cylinder of the eight V-motor built by the Ferro Machine and Foundry Co., Cleveland, Ohio. The motor itself was shown and described on page 19. This article takes up three other parts of this same motor including the cam-gear housing, cylinder cover and cylinder head. The tools shown for the first mentioned piece are for the operations of milling, drilling and boring, for the second, milling, drilling and boring; and for the third, milling, drilling and reaming. A feature of the milling fixture for the cylinder head is the arrangement by which two castings are held at the same time. One of the castings has its upper surface in position for machining and the other its lower.

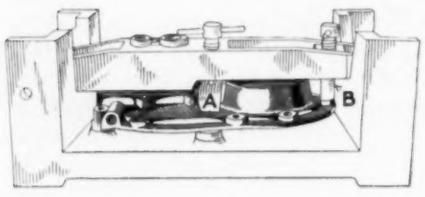


FIG.2

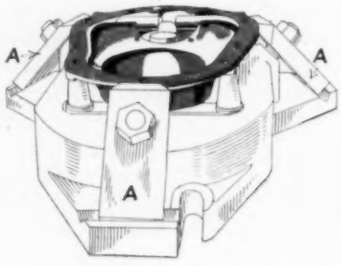


FIG.3

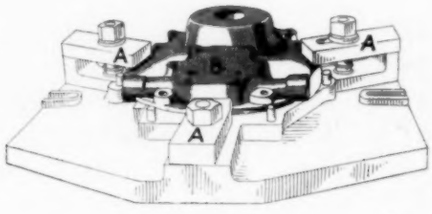


FIG.4

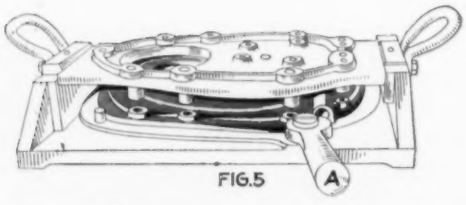


FIG.5

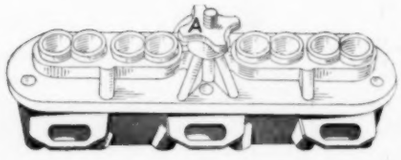


FIG.8

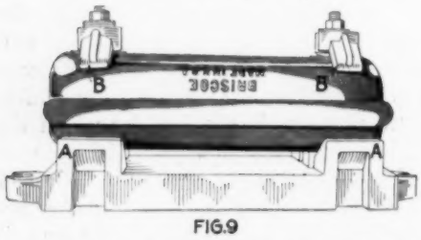


FIG.9

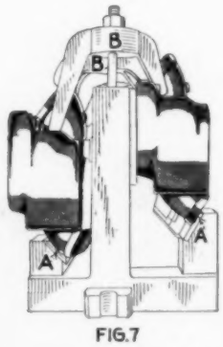


FIG.7

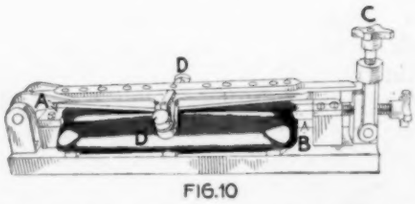


FIG.10

JIGS AND FIXTURES FOR MACHINING EIGHT V-MOTOR CAM-GEAR HOUSINGS; CYLINDER HEADS AND COVERS WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Boring and counterboring cam-gear housing. This rests on steel pads and is located by two pins which fit into previously machined holes. The cover is then fastened down, equalizing clamp A and screw B holding it securely.

Holes Machined—One ½-in. drilled and reamed and one ⅞-in. drilled and reamed.

FIGS. 3 AND 3-A

Operation—Milling parting line surface on cam-gear housing, Fig. 1. This rests on three fixed pins and two equalizing pins. Clamps A hold it in position.

Surface Machined—Parting line, using 12-in. inserted-tooth cutter. Speed, 16 r.p.m.; feed, 0.125 in. per revolution.

FIGS. 4 AND 4-A

Operation—Milling pad on cam-gear housing. The part rests on hardened-steel pads and is set between locating pins, straps A holding it in position.

Operation—Milling pad B, using 5-in. end mill. Speed, 50 r.p.m.; feed, 0.083 in. per revolution.

FIGS. 5 AND 5-A

Operation—Drilling all small holes in cam-gear housing. The part rests on machined surface, forced back against pins with the cam lever A. The cover is dropped down and the jig base is located by dowels.

Holes Machined—Nine $\frac{11}{32}$-in. and six ¼-in., drilled. The latter are then tapped with $\frac{5}{16}$-in. U. S. F. threads.

FIGS. 7 AND 7-A

Operation—Milling both sides of cylinder head, Fig. 6. Casting rests on hardened-steel blocks as A and is held securely with open-type straps B. The faces are milled, using 6-in. gang cutters. Speed, 40 r.p.m.; feed, 0.083 in.

FIGS. 8 AND 8-A

Operation—Drilling and reaming valve bushing holes in cylinder head. They are located by pins which fit into holes previously machined and held with a hook bolt operated by the knob nut A.

Holes Machined—Eight, bored and reamed to 1.3125 in.

FIGS. 9 AND 9-A

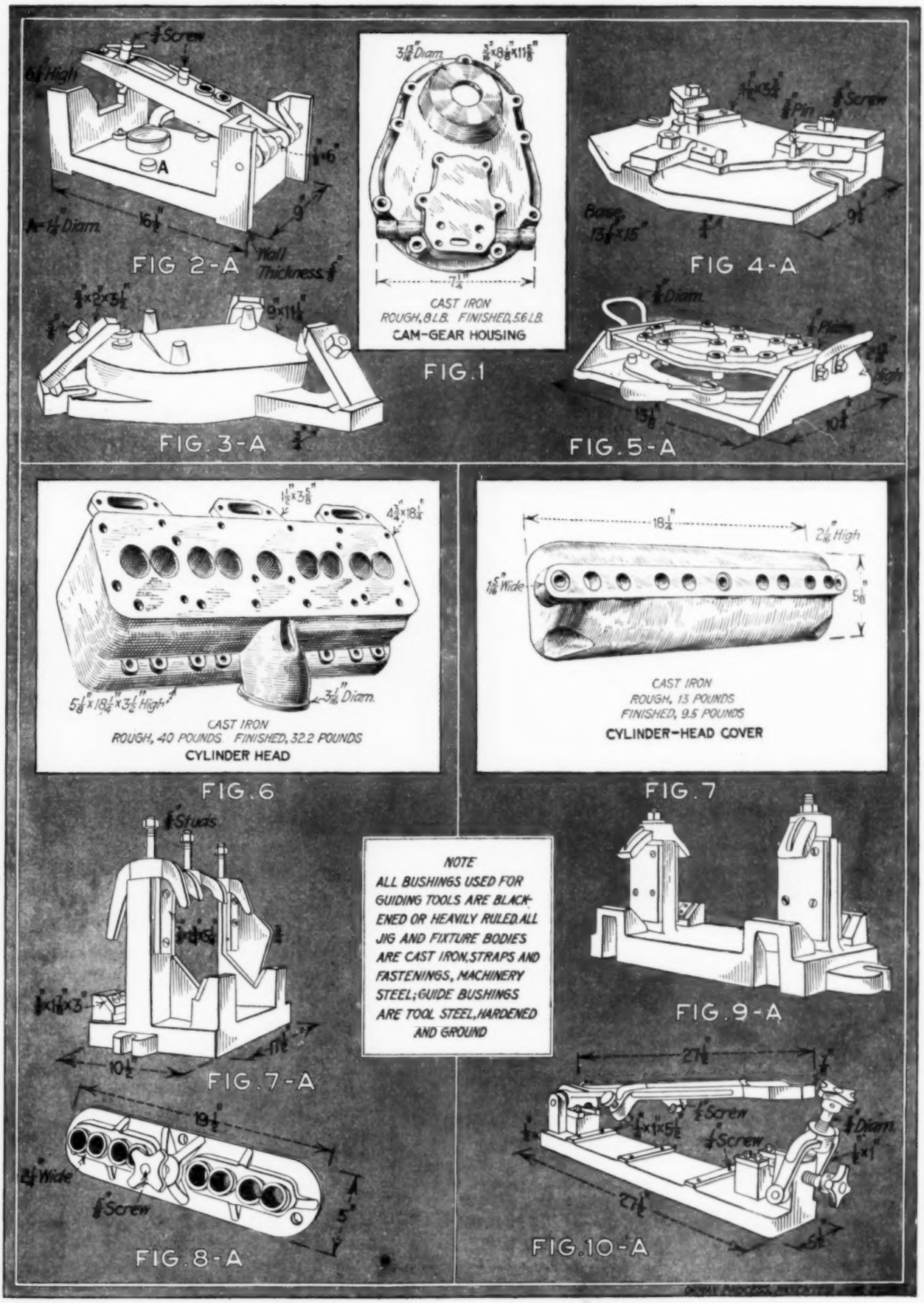
Operation—Milling outside surface of cylinder-head cover, Fig. 7, parting line surface being disk-ground. The casting is placed against a hardened-steel plate resting in two V-surfaces A. Clamps B, tightened down with nuts, hold two parts at one setting.

Surface Machined—Outside pad, using gang cutters 2½ in. in diameter, operating at 107 r.p.m.; feed, 0.083 in.

FIGS. 10 AND 10-A

Operation—Drilling and reaming, holding down bolt holes and spark-plug holes. The casting is located by V-block A, being forced back with the screw-actuated block B. The part rests on hardened-steel pads. The cover is then dropped down and held with the knob screw C. Knurled-head screws D hold the casting down.

Holes Machined—Eight $\frac{11}{32}$-in. and three $\frac{11}{32}$-in., both drilled.



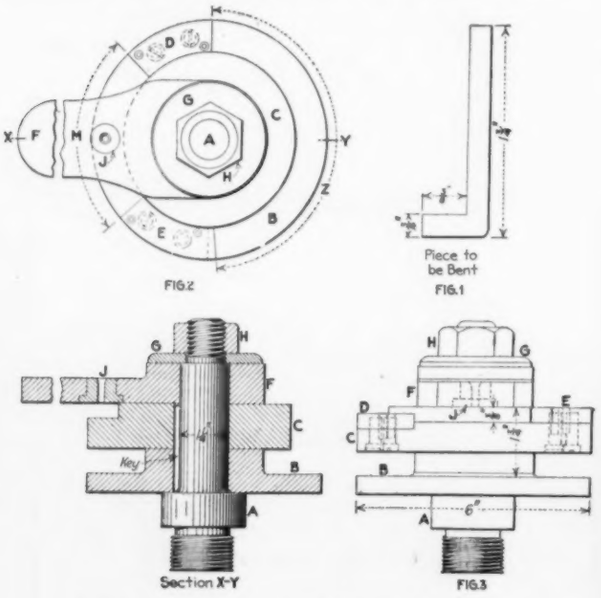
DETAILS OF JIGS USED IN MACHINING CYLINDER HEADS AND COVERS FOR 8 V-MOTORS

A Single Wire Bending and Cutting Fixture

By William Schneider

The fixture shown in the accompanying sketch was designed to bend and cut off brass wire. An engine lathe was used for this job because production was a very important part of our contract, which called for a specified amount to be shipped weekly.

The cost of making a punch and die for the punch press was found to be too great. At the same time it would not give the needed production, so a simpler and less expensive device had to be made that would give the desired production with a boy as the operator. The pieces (one being shown in Fig. 1) for which this device was



WIRE BENDING AND CUTTING FIXTURE

designed were bent and cut off at the rate of 40 per minute. The operator received the wire wound on hollow wooden disks, which were then placed on a reel at the end of lathe, this method making it easy for the operator to feed by hand through the guide, or die, *J*.

The fixture was made with a threaded shank *A* that screwed into the lathe spindle. The arm *F* was made long enough to rest on the outer edge of the lathe bed, in order to hold it steady while bending and cutting off the wire, which was done in one revolution of the spindle. Length plate *B* and cutter plate *C* were keyed to shaft *A*, while arm *F* was made a free running fit and held close to *C* by the nut and washer at the end.

The device operates as follows: The wire is run through the die *J* and held against the face of the plate *C* while revolving distance *M*, Fig. 2. Then the bending block *D*, which is held to the face of plate *C* and the thickness of the wire from the face of die *J*, bends the end. After the bending block passes the die, the wire is again run through and held against the face of plate *B* while revolving distance *N*, Fig. 2. The cutting block *E* now passes the die *J* and cuts off the wire, completing the operations.

The few general dimensions are shown to give an idea as to the size of this device. Fig. 3 shows another view of the fixture.

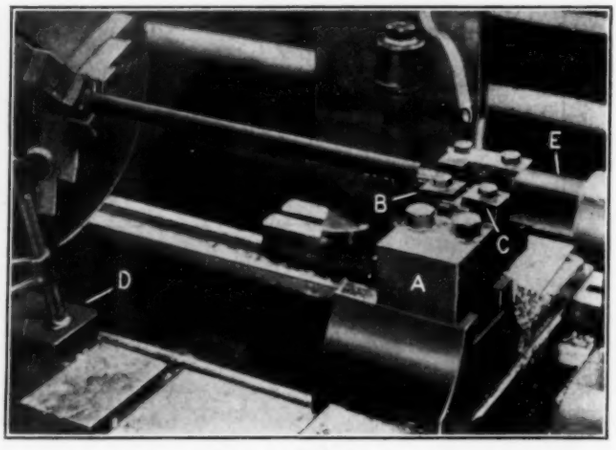
It was found by trying different speeds that 35 to 45 r.p.m. gave the best results, both for ease of feeding and for bending the wire. This fixture can also be used for cutting off straight wire to any length within the distance from the face of the die to the machine head, by removing the bending block *D* and the plate *B*, then fastening the stop the desired distance from the face of the die *J*.

Doing a Screw-Machine Job on a Plain Lathe

By E. A. Thanton

Not long ago a certain company wanted 5,000 pieces of cold-rolled steel $\frac{5}{8}$ in. in diameter by 14 in. in length, with one end turned down to two different diameters and lengths; that is, the extreme end had to be turned to $\frac{3}{16}$-in. diameter and $\frac{1}{4}$ in. back, and from this shoulder it had to be turned $\frac{3}{8}$ in. in diameter $\frac{9}{16}$ in. farther back to a shoulder.

The contract was given to the Verdin, Kappes & Verdin Co., Cincinnati, Ohio. There was no screw machine available in the shop, so a plain lathe was rigged up to do the work, as shown in the accompanying view. A box tool *A* was made and clamped to the tool block. The two cutters needed were held by means of the clamps *B* and *C*. The guide for the end of the rod is not a round bushing, as usual, but is square and serves to take off the slight burr made by the first cutter on the outside



LATHE RIGGED UP FOR A SCREW-MACHINE JOB

diameter of the shoulder. The tailstock and spindle *C* are locked solid and serve as a back stop against which the box tool is run when inserting the work. The rod is then inserted in the jaws of the universal chuck, and the outer end is butted against the side of the box tool. The chuck jaws are then tightened, giving the rod the correct setting. The carriage is fed to the left until it butts against stop *D*, which is set to give the correct shoulder length for the cutters to turn.

The work can be handled very rapidly in this manner, and on a trial run 80 pieces were turned in an hour. An average of about 60 per hour is made by the boy on the job, which gives a comfortable margin.

Grinding on the Side of a Wheel Is Objectionable, and to overcome this practice the side of the wheel should be painted and the pores filled in, which will eliminate the possibility of grinding on the side.

Personal Reminiscences of James Mapes Dodge--I

By Charles Piez*

SYNOPSIS—In these personal reminiscences Mr. Piez tells of the struggles, early failures and final great successes of one of the most commanding figures in American invention and engineering, and shows us the genial, charming personality of one who did much to shape our present-day industrial ideals. This first part deals with the development of the conveying and coal-storage business and covers a period of Mr. Dodge's life down to about 1900.

Twenty-five years of business association, 25 years of intimate personal relationship, were brought to a close by the untimely death of James Mapes Dodge on Dec. 4, 1915, and these notes are penned while grief is still poignant, while the sense of loss sustained is still acute. Memory has been active in recasting the story of our association, in reviewing the development of a great art, in paying tribute to the genius to whom that development was largely due. For he was a genius, one to whom the accomplishment of today was but an augury of the possibility of tomorrow; a ceaselessly active, dynamic man eternally in quest of progress, yet an easily approachable and thoroughly human man, with deep affections, tender considerateness and an inexhaustible and never failing sense of humor.

Mechanical accomplishment, even though its influence reaches into every home, rarely receives wide public mention. The fact that it has been a source of pecuniary profit seems all sufficient in the way of reward. And yet the lessons to be learned from mechanical progress and the examples set by our notable inventors may have wider public application and deeper public influence than the much heralded attainments of statesmen or the widely recorded works of our men of letters.

It is in the hope that these reminiscences of a man who will occupy an important place in the mechanical inventors' Hall of Fame will prove of profit to the workers in the mechanical arts that they are offered in these columns.

In the spring of 1889 an advertisement appeared on the bulletin board of the School of Mines, Columbia College, for two engineering draftsmen, signed by the Link-Belt Engineering Co., of Philadelphia. My application in response to this advertisement was accepted, and I became a member of the Link-Belt organization immediately thereafter. The vice-president and chief engineer of that organization was James Mapes Dodge. He had been connected with William Dana Ewart, the inventor of link belting, for some years, had assisted him in the design of the detachable chains and their attachments, and more than any other man had begun the application of chain to purposes of conveying and elevating material.

FIG. 1. ORIGINAL DODGE COAL-STORAGE PLANT OF THE READING RY. AT PORT RICHMOND, PHILADELPHIA, PENN.—THE BEGINNING OF A BIG BUSINESS

This period was followed by several years spent as superintendent of the malleable-iron foundry at which the chains were made, from which position he resigned to conduct some experiments on steel castings in Philadelphia. Upon the conclusion of these experiments, he became associated with Edward H. Burr, who then had the Pennsylvania agency for the Ewart Manufacturing Co. Under the firm name of Burr & Dodge, the application of chain to conveyors and elevators was pushed with such zeal that but for the kindly financial aid of Mr. Burr's father, a receiver would have ended the partners' efforts in the new field. The losses sustained grew out of inexperience, out

*President, Link-Belt Co.

of the optimism of the enthusiast. Mr. Dodge had invented a new chain known as the Dodge chain, a unique and distinct improvement on the old cable chain, and he felt he had practically found in it a solution of all conveyor problems. Joseph Cavanagh was in those days the only salesman of the firm, and when Joe came back from the anthracite region with his first order for a Dodge chain conveyor, the firm members came near meeting him with a brass band. If they had so met him and had known what the future held in store for them, they would have had the band play a dirge, for that order was but the first of the series that almost put the firm out of business. The experience was an expensive but nevertheless a very profitable one, for it was a much chastened enthusiasm that met the future problems; and experiments were thereafter conducted at home instead of in the plants of customers.

By 1888 Burr, Dodge and the New York office of the Link-Belt Machinery Co. had prospered to such an extent that a consolidation of the two interests was proposed by Mr. Dodge, and finally effected. The Link-Belt Engineering Co., of Philadelphia, grew out of this consolidation, and this company became the exclusive agent of the Ewart Manufacturing Co. for the Atlantic Coast States, the Link-Belt Machinery Co., organized in Chicago in 1880, retaining the agency for the rest of the country. While Mr. Ewart was president of both the Link-Belt companies, Mr. Dodge was the executive as well as the engineering head of the eastern company. Under his leadership there began an era of invention and development that in the retrospect appears little short of marvelous. Over 120 patents were taken out for him by the firm of Howson & Howson alone, and these patents cover only his later period of inventive activity. His inventions during this later period, beginning in 1884, pertained largely to conveying problems and to transmission chains.

Several years before I joined the organization he had conceived the idea of storing and reloading anthracite coal by mechanical means. In the preparation of anthracite for the market all sizes, from the largest domestic size to the smallest steam size, are produced. The demand for these sizes varies very materially, the steam sizes being in fairly uniform demand the year through, the domestic demand being active in the fall and winter but very light the rest of the year. To equalize production and to take care of the wide market fluctuations, a considerable portion of the anthracite output must be stored between the mine and the market. Storage of anthracite, when Mr. Dodge entered the field, consisted largely of dumping the cars on trestles and reloading with wheelbarrows. The cost averaged fully 40c. for the round trip, without taking into account the loss through degradation, which in this method of handling averaged fully 20c. more.

Mr. Dodge conceived the idea of piling the coal in conical piles and performing both the operation of stocking out and reloading mechanically. His ideas on this subject struck his associates as so bold and radical that they were unwilling to jeopardize the financial integrity of the conveyor business by this bold flight into fields untrodden. But nothing daunted, he proposed that they put up some money for an independent company and permit this company to install the storage systems. In those days, like most inventors, Mr. Dodge was considerably longer on ideas than he was on cash, and he was therefore under the constant necessity of inducing his moneyed associates to furnish the funds. Fortunately for both his associates and himself he was a magnetic and convincing talker and finally won a rather reluctant consent to his proposition. Ten thousand dollars was put up in cash, and a company known as the Dodge Conveyor Co. was organized. It contracted to store and handle a certain yearly tonnage for the Philadelphia & Reading Ry. at Port Richmond. In spite of limited means, inexperience and the crudest of crude machinery, his ideas proved sound and the contract financially remunerative. A second contract was thereupon secured from the Pennsylvania R.R. at South Amboy, in which an actual sale of the machinery was made to the railroad company. The soundness of the idea met with such prompt acceptance that further contracts for two plants were secured from the Delaware & Hudson company.

One of these covered a storage plant of 150,000 tons' capacity, to be located on a narrow island in the Hudson River at Rondout, N. Y. The system of storing as it had been developed at that time is illustrated in Figs. 1 and 2, and consisted of a mast and boom which carried the stock-

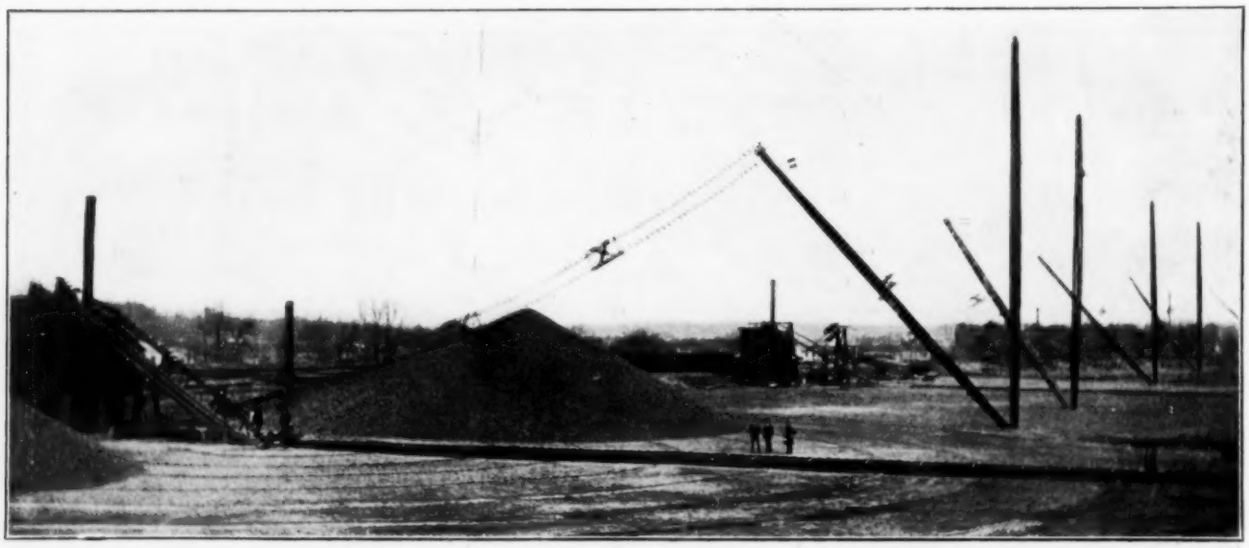


FIG. 2. IMPROVED MAST-AND-BOOM PLANT OF THE PENNSYLVANIA R.R. AT SOUTH AMBOY, N. J.

ing-out conveyor head machinery. The mast had to be securely anchored to guy ropes, which of necessity had to lead away from the coal pile. At Rondout Mr. Dodge almost met his Waterloo, for after the company had been awarded the contract he found the island just wide enough to hold the coal piles, and to use his own expressive phrase, "There wasn't a darn thing to anchor the guy ropes to except the swift current of the Hudson River."

But the difficulty was met in a very ingenious fashion, for right on the spot he developed the idea of spanning the piles with light hinged trusses and securing them against side wind pressure by anchor and guy ropes. This put the guy ropes lengthwise of the island, where there was plenty of terra firma for anchorage. The change, while adding considerably to the cost, added materially to the effectiveness of the storage system, for it afforded him the opportunity for the invention of the ribbon-bottom conveyor, which aided so materially in reducing the breakage of coal.

FIG. 3. SHEAR-TRUSS CONSTRUCTION INVENTED AS A RESULT OF THE RONDOUT EXPERIENCE; SUSQUEHANNA COAL CO.'S PLANT AT OLD BRIDGE, N. J.

Compare the two cuts, and the tremendous step ahead attained by the invention of the shear-truss construction will be apparent at a glance.

The unsuitability of Hudson River water to serve as an anchorage for the mast and boom construction had developed the idea that was needed to round out and perfect the system. It became the recognized method of storing anthracite coal in large quantities and has remained so. See Fig. 3.

Mr. Dodge's invention was absolutely generic, and he was entitled to the broadest kind of patent protection; but a poorly drawn set of claims opened the doors to a competitor, who sold one plant. The patent office, recognizing the merits of Mr. Dodge's invention, granted his application for a re-issue, and the amended process claim was so carefully and yet so simply drawn that we were never again subjected to infringement.

Those days in the late eighties and the early nineties were active, interesting days. The conveying art was so young that few standards had been developed and a broad field for invention lay open before us. The shops worked in a happy though leisurely fashion, but the margins of profits were large and there was no immediate incentive for systematized intensification of production. In 1889 when the plant at Nicetown, Philadelphia, was built, Louis Wright was appointed superintendent. He was a capable man who had served several years of apprenticeship under Frederick W. Taylor, who was then at the Midvale Steel Works. Mr. Wright gradually brought about some semblance of orderly procedure in the manufacturing departments, though it was done only after a lot of argument and after the exercise of some pressure. For Mr. Dodge worked on impulse and looked upon any systematic procedure that harnessed or directed impulse as an unnecessary and unwise restriction of initiative. When Louis Wright argued that the execution of a customer's order should take precedence over the carrying on of an experiment, Mr. Dodge very reluctantly assented; but when Louis Wright argued for a further extension of system and records, Mr. Dodge said: "Louie, in the several years that you have been here, the only decision of any importance that you unearthed out of this mass of records was that when you wanted to paint a fence it was cheaper to use dressed lumber than rough lumber. I could have guessed that if you had asked me." His contempt for records in those days is particularly interesting because 15 years later he became recognized as the most ardent advocate of the Taylor system.

His attitude toward college men underwent a similar change. Though a college man himself, his quick mind grasped mechanical and mathematical facts without the necessity of demonstration. He looked upon many of the mathematical propositions as self-evident and rebelled at the idea of being compelled to prove axioms. The whole college curriculum struck him as a perhaps necessary program for dullards but as unnecessarily restrictive to the student of wide mental grasp and quick perception.

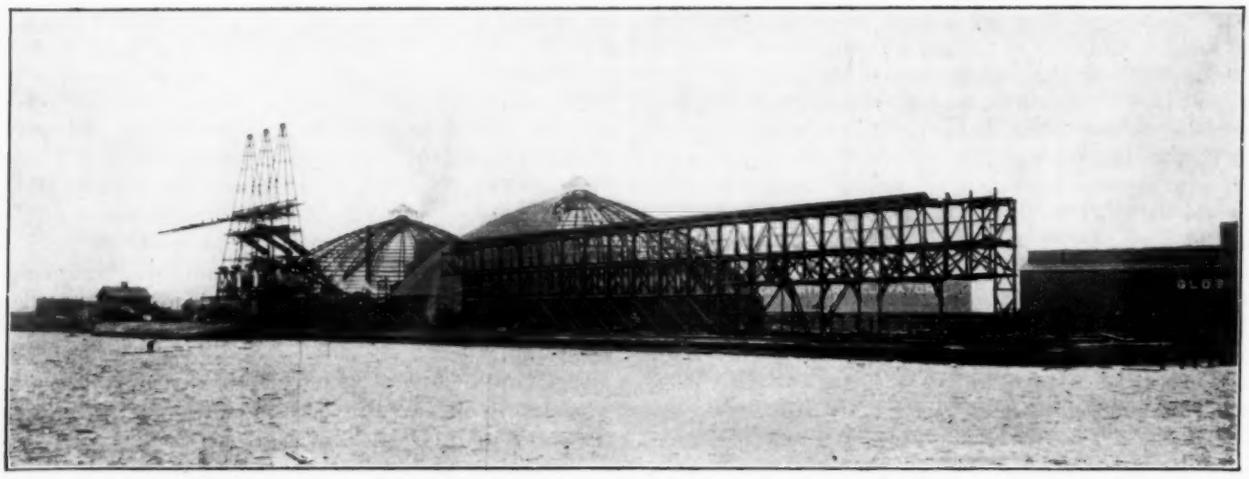


FIG. 4. CIRCULAR STORAGE BUILDINGS OF THE LEHIGH VALLEY PLANT

In his own experience he felt that his work in the shop had been of tremendously greater help to him than his work at college, and he was apt to minimize in those early days the practical value of technical training.

Yet in his annual address on the "Money Value of Technical Training," delivered in 1903, while president of the Society of Mechanical Engineers, he states, "The progress of the world, however, calls for a better and more speedy means of producing trained men than can ever be developed by the methods of self-instruction," and the chart accompanying the address—developed as the result of exhaustive analysis—shows the high esteem to which the graduates of technical schools had risen.

Our work had gradually taken on an engineering as well as a mechanical aspect, and the rapidly expanding engineering department gave him an excellent opportunity to compare the technically trained with the self-trained men. He realized upon investigation that while some technically trained men were absolutely lacking in mechanical instincts, and while more perhaps were wholly lacking in commercial sense, yet on the whole the percentage of capable and successful men developed out of our collegiate employees largely exceeded those developed out of the self-trained class.

A Unique But Very Simple Engineering Invention

During 1893 and the succeeding years our business gradually declined in volume as a result of the general depression following the Baring failure, and we were compelled in order to keep the plant going to take on several large contracts that were more hazardous than they were remunerative. The most conspicuous of these contracts was that taken from the Lehigh Valley Coal Co. for its coal dock at West Superior. We were called in at the very last minute and given an opportunity to bid. The problem submitted consisted in storing 50,000 tons of stove and 50,000 tons of nut anthracite coal under cover and 40,000 tons of bituminous coal in the open, the coal to be taken from vessels and delivered from storage into cars. The Lehigh Valley had practically decided to adopt a plan

FIG. 5. CIRCULAR ANCHOR BAND TO WHICH THE OUTER WALL IS SECURED

consisting of wooden sheds into which the coal was to be distributed by means of a cable railway. Mr. Dodge, under the stress of this seemingly insurmountable competition, developed his covered storage system, convinced the Lehigh Valley of its value and secured the contract for upward of $260,000, in spite of the fact that the plan was wholly untried. The plant brought with it a train of engineering and mechanical problems, all of which were successfully met, but the particular idea which made it possible to secure the contract was a unique but very simple engineering invention.

The plan submitted by Mr. Dodge included the use of two circular buildings, 246 ft. in diameter, 90 ft. high, with vertical retaining walls 17 ft. high (see Fig. 4). Now the pressure exerted by anthracite coal is about one-third of water pressure when the coal is level with the top of the wall, and fully one-half of water pressure when the wall is surcharged, and the structure necessary to take care of this pressure loomed up as one involving prohibitive expense. Imagine a boiler 246 ft. in diameter with a pressure of 510 lb. per sq.ft., and you will get some idea of the structural problem involved. But Mr. Dodge decided to make the coal sustain the wall, and while it seems paradoxical to say that the material that causes the pressure can be made to sustain that pressure, yet that is exactly what his scheme contemplated. The illustration, Fig. 5, shows a section of the building and illustrates the use of the anchor band which solved the problem in very simple and economic fashion. The band is circular and is suspended about 30 ft. inside of the retaining walls. In the operation of stocking out coal a section of the band is covered before any pressure is exerted by the coal against the corresponding section of the wall, and the necessary anchorage to the band is readily secured by light rods.

The retaining walls were constructed of 8-in. I-beams and No. 10 corrugated metal, the anchor band of $\frac{5}{16}$-in. steel 3 ft. wide, but this simple and cheap construction has stood up without flinching for 20 years.

(To be continued)

Lubrication and Wearing of Tooth Wheels

By Hugo Friedmann

The question was recently raised whether it would be feasible to use an oil-film lubrication such as proves to be the best expedient for journal bearings to protect tooth wheels against wearing. In order to ascertain the value of this suggestion, we start with the consideration of a few physical properties.

It is a well-known fact that two pieces of perfectly straight plate glass, one laid upon the other, can hardly be separated in the direction *A*, Fig. 1. There exists between such polished surfaces a special mechanical attraction called adhesion. In the direction *B*, however, Fig. 2, the pieces may be easily separated. This difference of conditions is very remarkable and important.

Problem of Adhesion Applied to Gears

It is useful in considering the problem of tooth-wheel lubrication to remember how the physicists explain the phenomena of adhesion. They suppose that every substance has the property of attracting other substances. The influence of big masses reaches far (for instance, the attraction of the earth controls the motion of the moon), whereas the influence of those smallest particles that build up every material is effective only within the range of ten-thousandths of an inch. Between two separate bodies it cannot be observed therefore unless a high polish and perfect straightness of their surfaces permit bringing them very close together. This fact explains the strong attraction in direction *A*, Fig. 1.

Now as to conditions in Fig. 2. The influence of every particle is radiated in all directions of the space; but not all these forces may cause a visible effect. Looking at the simplified section, Fig. 3, we understand that the particle 1 in the body *A* is chiefly attracted by the particle 2 situated just opposite the body *B*. Particles 3 and 4 will likewise attract particle *A* and try to move it to their side, but these forces will annul each other. If then an exterior influence acts in the direction *C*, it is added to the influence of 4. The equilibrium is disturbed, and the body *A* will move to the right hand. Adhesion has no practical influence in this case, and the frictionless condition of the bases makes sliding very easy.

Practically the same results are obtained if a thin film of liquid is between the two bodies. This film has the additional effect of equalizing the solid surfaces to a certain extent, even if they are not perfectly smooth. For the liquid is able to fill minute irregularities, and the adhesion may act from one solid to the liquid and through this to the second solid. Adhesion becomes therefore more effective and sliding easier. This is the common influence of lubrication.

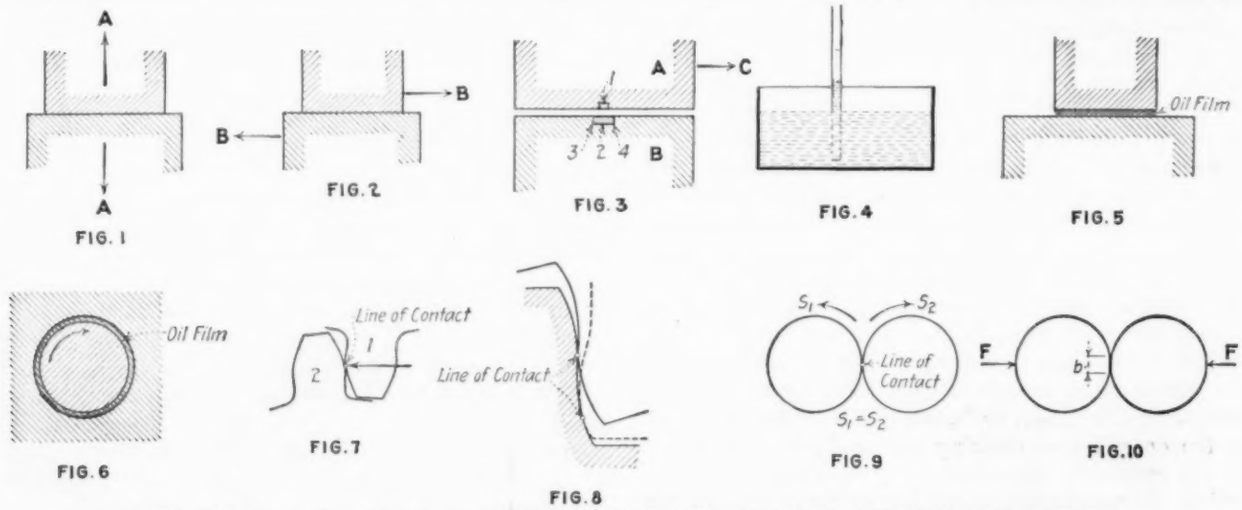
Capillary Action of Oil Discussed

Still another phenomenon has to be considered in the case of a liquid film—the capillarity. Capillarity may be observed best when a plain tube of narrow gage is inserted with one end in colored water. The liquid will be seen ascending in the tube far above the outer coil against the influence of gravity, Fig. 1. This phenomenon is another result of adhesion between solids and liquids. The same sucking form as in the glass tube is effective between two straight plates that are approached very closely without touching each other. This force hinders the lubricant from running out of the gap; more than that, this force acts so that the oil can hardly be squeezed out from its location by outside pressure. As a consequence the upper plate, Fig. 5, does practically float on the liquid film.

If we imagine these plates and the film rolled up to a cylindrical shape, we get exactly the conditions of a journal bearing with oil-film lubrication, Fig. 6. The rotating journal is actually sliding on the bearing surface, and the oil film is constantly maintained by the capillarity of the minute gap between bearing and journal. Experience proves that it is not destroyed even at the bottom of the bearing.

After having made clear these conditions we may proceed to study whether they can be imitated with tooth gears. The teeth always press each other along one line of contact only, Fig. 7, and in moving, this line is continuously shifted from one place to another. If we assume, just for the purpose of making the matter clear with a stationary drawing, that tooth 2 is resting, the relative position of tooth *I* will move from the full-

to the dotted-line position, Fig. 8. There is no sliding, theoretically, but a kind of rotating around a movable center. By this motion the gap is opened at one place and closed at another. The lines that were just touching each other are separated by force in the next moment, an action perfectly comparable to the one shown in Fig. 1. This motion acts against adhesion; it does not offer a continuous gap, and it destroys the oil film. In the action of tooth gears, as this motion cannot be changed, it becomes evident that their principle is strictly contrary to the conditions for oil-film lubrication. There is no chance therefore to reduce the recessing of spur gears by this form of lubrication. For worm gears the case is quite different. The motion of the worm is to a great extent a sliding along the teeth. Worm gears may therefore be efficiently protected by an oil film.



MECHANICAL CONSIDERATIONS IN THE LUBRICATION AND WEARING OF TOOTH WHEELS

In order to keep the wearing of tooth gears within safe limits, other expedients have therefore to be chosen. They are generally known but not always fully appreciated, and it may be instructive to discuss connection with the preceding considerations.

As stated above, the motion of the teeth relative to each other is essentially a rolling. We consider therefore first the process of plain, ideal rolling. As shown in Fig. 9, two rolls moving in opposite direction with the same speed do not slide at all upon each other. Consequently there is no friction and no wearing. When, however, the rolls are exposed to considerable pressure from both sides, the material will be flattened by elastic deformation; and instead of the original line of contact, there will be a temporary face of contact of the width b, Fig. 10. The destruction of the true circular shape changes the original frictionless rolling into a more complicated motion, and a partial sliding of the fibers, in addition to the high local stress by pressure, causes wearing.

The same consideration may be immediately applied to tooth gears. It teaches us first that the load must be kept within certain limits, proportionate to the size of the teeth; secondly that these limits depend also upon the kind and quality of the material. In most cases where tooth wheels are worn out, it is caused by a load that exceeds the capacity of the size of the wheels and the elastic properties of the material. Moreover it has to be considered that the motion of the teeth is of a complicated character, if compared with the plain rollers, Fig. 9. As a matter of fact there must always be some sliding. In order to reduce this influence as far as possible, the outline of the teeth should always approach the theoretical shape as exactly as possible. The importance of clean, exact cutting and of the maintenance of the correct distance becomes therefore evident.

In the last place, lubrication may be of value. It reduces the friction of that amount of sliding which cannot be entirely avoided. As the action of capillarity and the establishing of an oil film cannot be depended upon, and in addition to that the centrifugal force tries to throw off the lubricant, it is necessary to use rather a thick grease which clings to the material by its toughness and envelops it everywhere. Under unfavorable conditions it is advisable to inclose the whole gearing in a tight sheet-metal case and to fill this with grease.

Effect of Lubricant on Taps

C. T. Brunson, of the Wabash R.R., reported to the American Railway Tool Foremen's Association that he found a great deal of trouble in stripping threads in boiler shops to be due to the character of the lubricant used on the tap. The majority of machines on the floor have one oil can, and the oil in that can is used to oil the motor, to wash the men's hands, on a tap, or reamer, or on whatever comes along. Whenever instructions are given the men on the floor to use the proper lubricant for tapping, there will be eliminated a great deal of trouble in stripping threads. Mr. Brunson further stated:

"I have had men on turret lathes tell me that the only thing with which they can tap on their machines is white lead and a composition of soapy water. I have had to show them that they are wrong, that there are lubricants that beat that all hollow. In fact there was one man who was very positive. He had been running a turret lathe for a number of years and was sure that he knew all there was to know about the matter. He knew so much about it that he would not try the oil until I took the drill press and did a better job of tapping on the drill press than he could do on the turret lathe. Then he began to pay attention. But that is where a good deal of our trouble comes in the way of stripping threads in tapping, because of the use of the wrong lubricant."

Making 22-Caliber Sheet-Steel Rifle Barrels

By Ethan Viall

SYNOPSIS—Ordinarily a rifle barrel is made from a solid bar, drilled out, and then rifled in a special machine. The rifle barrels described in this article are made from sheet metal, and the rifling is produced in a punch press by a unique method. Besides the making of the rifle barrel, several other interesting shop processes are shown and described.

The making of a rifle barrel from sheet metal sounds unusual enough to attract attention, yet the process is not so complicated as one might imagine, though it shows considerable ingenuity. The type of rifle on which these barrels are used is shown in Fig. 1, where views of two of the models are given. The upper one is of the Boy Scout model, with bayonet, long fore-end and shoulder strap. The lower one is the regular target or light sporting model. With the exception of the stocks, fore-ends and a few rivets, these rifles are made entirely of sheet metal. They are made to use the regular 22-caliber cartridges, and are manufactured by the C. J. Hamilton & Son Manufacturing Co., Plymouth, Mich.

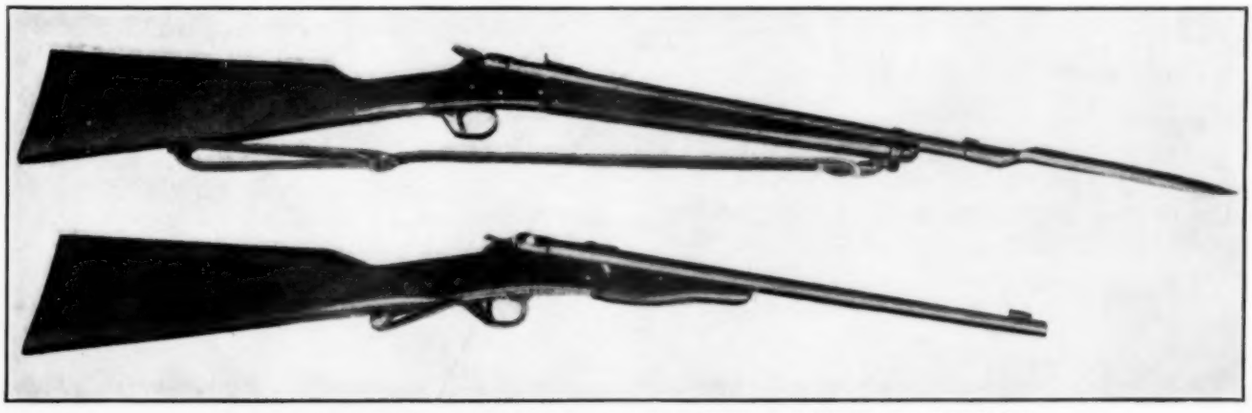


FIG. 1. TWO MODELS OF 22-CALIBER RIFLES WITH SHEET-STEEL BARRELS

As it is the most interesting process, the making of the barrels will be described first. These barrels consist of three tubes telescoped into each other, soldered solidly together and pressed into another tube which forms the outer part of the barrel. As previously stated, these parts are all made of sheet metal. In making the inner tube, or lining, through which the bullet passes, the sheet metal is cut into strips of the correct length and width, which are then bent lengthwise into U-shape in an ordinary die. The next step is to form these pieces into tubes, which is done in a kneading machine, as shown in Fig. 2. In starting, the work is placed as shown at *A*, with a mandrel in the channel. The work is of course pushed in far enough so that the metal is entirely between the jaws. The machine is then started, and the jaws rock up and down, kneading the piece into a tube with the edges butted closely together in a way that could not be obtained in a punch press with an ordinary closing die. This process is followed for the other sizes of tubes used. A strip bent into U-shape and a finished tube are shown at *B* and *C*.

The outer tubes are left straight, but the inner one is twisted so that the edges conform to the spiral of the rifling. This work is done in the machine shown in Fig. 3. The tube to be twisted is placed between centers, with one steadyrest to support it at *A*. The centers used are merely sockets to receive the ends of the tube and have a projection in them that engages the slit. With the tube resting in the socket centers, the operator pulls on lever *B*. The lever not only presses the driving projections of the sockets into the slits, but forces the headstock center inward. This action causes a clutch to engage, and the spindle automatically turns backward just the right amount to give the required twist to the tube, as a stop throws out the clutch at the right point. As soon as the clutch is thrown out and the twisted tube removed, the weighted strap *C* pulls the spindle forward to starting position ready for the insertion of another tube. The spiral lines on the tube *D* show how it has been twisted. The gears at *E* are for the purpose of obtaining the needed twist with the amount of pulley travel available.

The rifling is put into the inner tube not by cutting out grooves in it as usual, but by pressing or kneading the brass tube down over a spiral mandrel, after which the mandrel is forced out, leaving the interior of the tube of the same shape as the mandrel. Fig. 4 shows a twisted tube at *A*, a finished rifled tube at *B* and a mandrel at *C*. This mandrel is $17\frac{3}{4}\frac{1}{2}$ in. overall, without the handle. The spiral flat sides, 12 in number, are $15\frac{9}{3}\frac{}{2}$ in. in length, measured parallel to the center line and not on the spiral. The amount of spiral twist is one turn in 13.71 in. The short round part on the end is 0.208 in. in diameter. Measured with a micrometer at the outer end, the opposing flats are 0.217 in. apart; that is, the mandrel is that much in diameter there. At the end next the handle it measures 0.215 in. This shows the amount of taper from one end to the other. The making of the mandrel was a difficult job, and was

described in *American Machinist*, page 429, Vol. 31, though the actual manner of working with it is here described for the first time.

In using the mandrel, a twisted tube is run on over it, and it is then laid in the special kneading jaws in a punch press, at *A*, Fig. 5. It will be seen that there are four jaws in this device, and the tendency of them all is to work or knead the metal inward as the press ram descends. About 20 strokes are required to flow the metal closely around the mandrel to form the rifling.

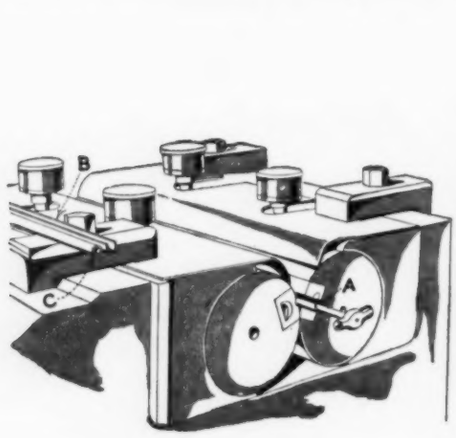


FIG. 2

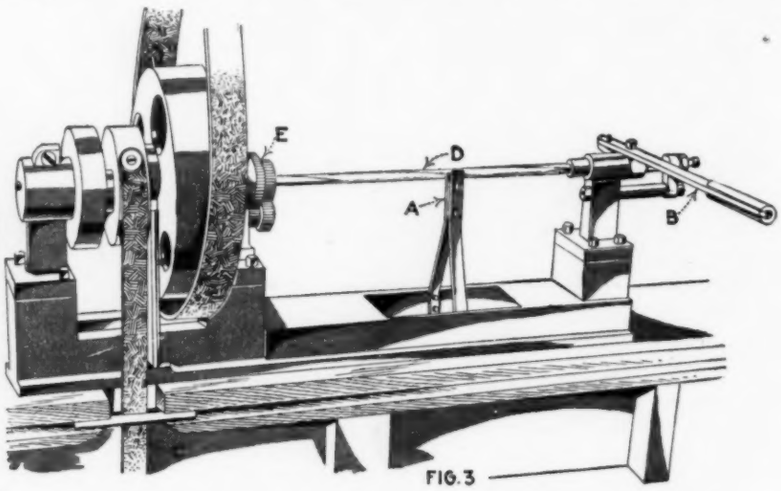


FIG. 3

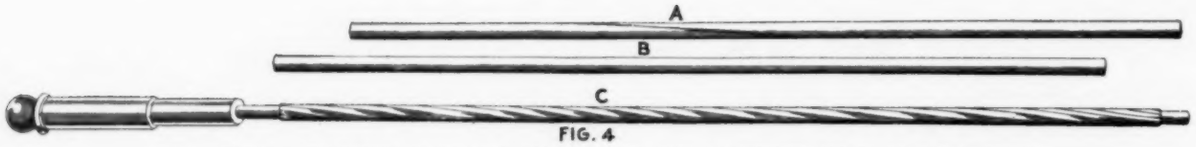


FIG. 4

FIGS. 2 TO 4. BARREL-HANDLING MACHINES AND MANDREL USED FOR TWISTING

Fig. 2—Kneading machine used as tube closer. Fig. 3—Twisting the inner tubes for the barrels. Fig. 4—A twisted and a rifled tube, with the mandrel used

After the tube has been thoroughly pressed around the mandrel, it is removed from the jaws and placed in the device shown in Fig. 6. Here the tube rests on a fork at *A*, with handle below. A rod *B* is run through a guide at *C* with the lower end resting on the end of the mandrel. As the foot treadle *D* is pressed down the rod forces the mandrel out of the tube. This sequence of operations shows the necessity for the taper for the mandrel, which without the taper would be extremely difficult to remove. With the rifled tube as a basis, the outer tubes are pressed on, the ends of the inner tube are plugged and all are dip soldered. After this, one end is chambered for the cartridge and the muzzle end machined off smooth. The other operations on the barrels are of minor importance and will not be described.

The hammers used in these rifles are blanked out in a punch press and the pin hole pierced. The thumb-hold is then profiled off, as shown in Fig. 7. Here the master form is shown at *A* and the hammer to be milled, at *B*. The hammer is located in the special vise jaws by means of the pin hole, which fits over a pin set into one of the jaws, and by a number of other pins among which it fits.

The cross-hatching on the thumb-hold of the hammer is knurled on in a special machine, shown in Fig. 8. The

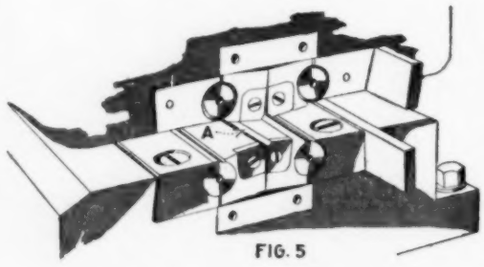


FIG. 5

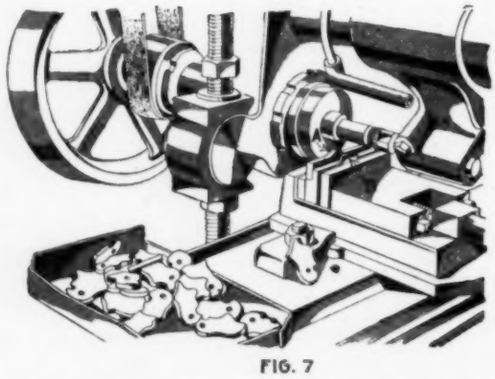


FIG. 7

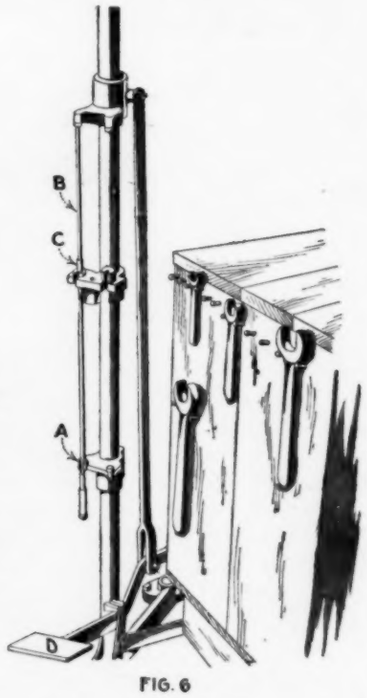


FIG. 6

FIGS. 5 TO 7. TWO BARREL KINKS AND A PROFILING JOB

Fig. 5—Press jaws used to knead the tube to the mandrel. Fig. 6—Special press for forcing out the mandrel. Fig. 7—Profiling the thumb-hold on a hammer

hammers are placed one at a time in a sort of revolving turret, as shown at *A*, *B* and *C*. As the turret slowly revolves, the hammers are carried past the two knurls at *D*, and the cross-hatching is automatically done. As a hammer is carried on around, the operator removes it and places another in its place, so that the work is continuous. A turret for another size of hammer is shown at *E*. It can easily be put on in place of the other.

The trigger guards used on some of the rifle models are first cut to length with the ends rounded and the screw holes pierced. They are then bent to shape in the device shown in Figs. 9 and 10. In Fig. 9 the piece to be bent is shown at *A*. By pressing down on a foot treadle the slide *B* moves forward and the first bend is made. This movement also brings up two plugs *C* and *D* from below. These two plugs are shown elevated in Fig. 10, and it is around them that the two end loops are bent. To bend the ends, the operator pulls on the lever *E*, which causes the two rollers *F* and *G* to rotate around the plugs, bending the ends of the guard as they travel. As the hand lever is returned to starting position and the foot treadle released, the two plugs drop down into the table, and the bent guard is easily removed. One of the guards is shown at *H*.

Rear sights are made from strip stock in the die shown in Fig. 11. A strip of the scrap is shown at *A*, and one of the sights at *B*. Other similar ones are shown in the foreground. A row of pierced holes will be noted in the strip of scrap. These holes are for stopping and piloting purposes, and are made by the punch *C*, the pilot being indicated at *D*. In feeding the strip through the die the sight notch and the hole are first cut by punches *E* and *F*, the punchings being shown at *G* and *H*. Punchings like those shown at *I* are then made by punch *J*. This leaves the part of the sight that is to be bent cut out on three sides. The punch *K* partly completes the bend, and the last punch, in which *L* is the pilot and *M* a knockoff pin, finishes it and blanks out the remaining part of the sight.

Another die, shown in Fig. 12, is used for making the parts at *A*. The piercing, blanking and forming are all done in this die. It will be seen from the pieces that the holes are not only pierced, but also shouldered. The final cutting off and forming are done by the two punches *B* and *C* as the stock feeds out through the guides of the die at *D*.

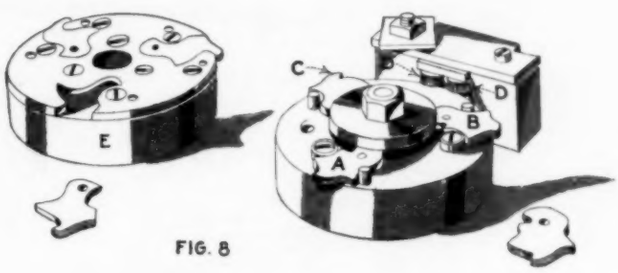


FIG. 8

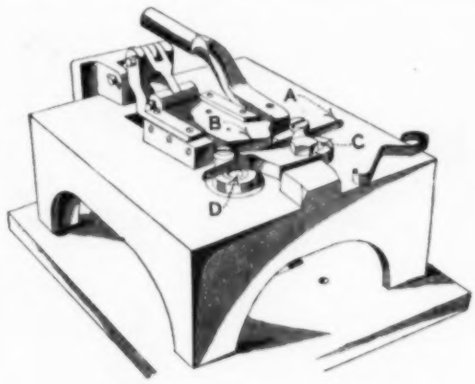


FIG. 9

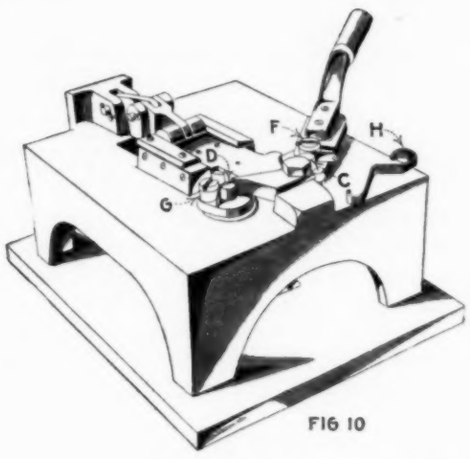


FIG 10

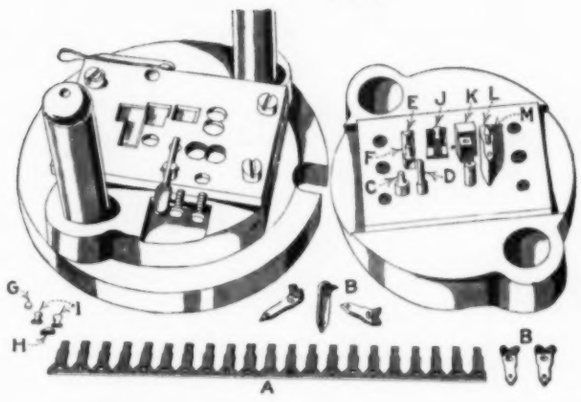


FIG. 11

FIGS. 8 TO 11. HANDY TOOLS FOR SMALL PARTS OF RIFLES

Fig. 8—Thumb-hold cross-hatching machine. Fig. 9—Trigger guard forming fixture. Fig. 10—Bending the end loops. Fig. 11—Die for making a rear sight complete

A Novel Use for a Drilling Machine

A drilling machine laid on its side for doing some special work is shown in Fig. 13. While this is practically a screw-machine job, a screw machine was not used because the work could not be conveniently handled through the spindle from the back. The job done is the facing and chambering of the ends of rifle barrels. The barrel is thrust in with the left hand through the hole at *A*. The chuck jaws *B* are tightened down on the barrel by means of the handle *C*. The tool *D* is fed to the work by means of the handle *E*. The spindle runs in the same way as usual, except in a horizontal position. It will be seen that the shortness of the large hole in the bracket holding the chuck is a great convenience in this case.

The handle loops on cleaning rods are formed in the fixture shown in Fig. 14. It differs somewhat from the usual type used for this purpose. The rod to be bent is thrust in between the center pin and the block *A* until it butts against a stop. This action brings the end close to the edge of the hinged member *B*. As the operator pulls on the lever *C*, this member forces the end of the wire around the center pin until it butts against the side of the block *A*. This movement brings the long part of the rod around parallel with the side of the block and

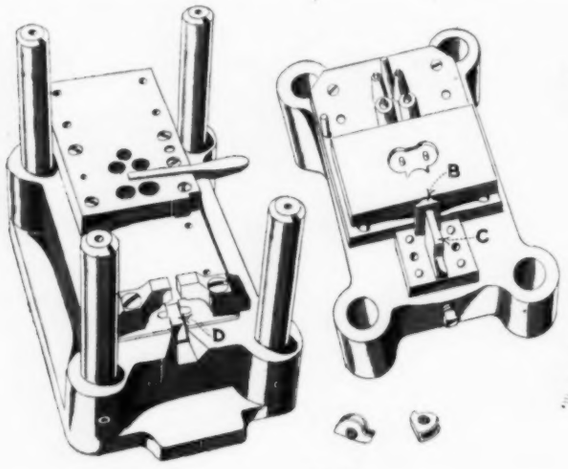


FIG. 12

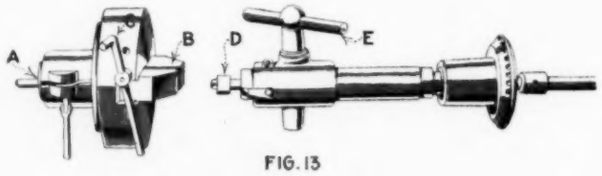


FIG. 13

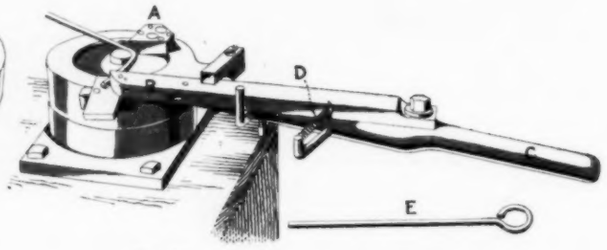


FIG. 14

FIGS. 12 TO 14. SPECIAL TOOLS FOUND EFFECTIVE IN MANUFACTURING RIFLE PARTS

Fig. 12—Die for making a special lever part. Fig. 13—Drilling machine used horizontally. Fig. 14—Wire loop-forming fixture

finishes the work. The swinging in of the end of part *B* allows it to keep its grip on the wire, which gradually shortens as it encircles the center pin. As soon as the lever is pulled back, the spring *D* pulls the member *B* back to the starting position ready for the next piece. A finished cleaning rod is shown at *E*.

*

Tungsten and Molybdenum

One of the most spectacular advances in commodity prices occasioned by the war has been in tungsten, both metal and ore. This has been due to the extraordinary demand for tungsten steel—an essential constituent in making high-speed tool steel. The manufacture of immense quantities of military material has required greatly increased quantities of tool steel, and consequently corresponding quantities of tungsten; hence the advance in price for it.

Before the war high-speed tool steel was worth about 70c. per lb., tungsten about 60c. per lb. and tungsten ore about $6 per unit. At present high-speed tool steel fetches about $3 per lb., tungsten about $5 per lb. and tungsten ore about $50 per unit. Even at the enhanced prices supplies are scarce.

The fabulous price for tungsten ore has stimulated prospecting for it throughout North America and South America. This ore is not known to occur in large deposits. The annual production of concentrated ore in the United States previous to the war was only about 1,400 tons. However, this ore has now become so valuable that the discovery of a deposit that affords a single carload is the finding of a fortune. A ton of ore assaying 60% tungsten trioxide—the standard commercial grade—at $50 per unit is worth $3,000; a carload of 40 tons would be $120,000.

A contributory factor in the production of this situation was the utter stupidity of the British authorities. They fought the advance from the beginning. When they were offered some tungsten ore, they came back with a lower bid—trying to dicker in what was not a dickering market—and naturally failed to get what they wanted. Then they practically commandeered the supply of tungsten ore in the British Empire, appointing offi cial brokers and fixing a price of 55s. per unit, or about $800 per 2,000 lb. of 60% ore if exchange be figured at 4.86. Previous to the war that would have been regarded as a fine price, but the producer in Australia, Burma, Malaya and elsewhere does not think very much of it when the same grade of ore is fetching $3,000 or so per ton in America. Patriotism does not go quite so far as that.

In the meanwhile there is relief immediately at hand if the manufacturers of tool steel would only avail themselves of it. We mean the substitution of molybdenum steel for tungsten steel. It is well known that molybdenum steel has excellent qualities of more or less the same character as tungsten steel. There is an extensive literature on this subject to which the tool-steel maker may refer. It is indeed claimed by some authorities that molybdenum steel is superior in certain respects to tungsten steel. The chronic reluctance of manufacturers to get out of the beaten tracks is offered as an explanation of their blindness to the merits of molybdenum steel. But even if it were not preferable with tungsten at 60c. per lb., it might be when that metal is more than eight times as high.

The point is that molybdenum ore and the products thereof are now a drug in the market. While the tungsten mines are being worked at the limit of their capacity, the molybdenum mines have had to be closed, and the smelters of molybdenum ore are carrying large unsold stocks of the products that probably they would be glad to sell at cost. The manufacturers of tool steel and the British authorities are recommended to give some attention to this situation.—*Engineering and Mining Journal.*

Empirical Design of Gas-Engine Piston Pins

By G. W. Lewis* and A. G. Kessler†

SYNOPSIS—Empirical formulas are given to obtain the diameter and length of piston pins, also the diameter of pin bosses used on the pistons. These are for both horizontal and vertical types of engines. The formulas have been derived from data received from manufacturers of various American engines and represent the best average practice.

In Vol. 39, pp. 775 and 891, of *American Machinist*, we gave empirical formulas for obtaining the dimensions of gas-engine pistons of the open-trunk type. The following empirical formulas on the piston pin and piston-pin bosses were obtained from data received from manufacturers of American engines and represent average practice.

The function of the piston pin is to transmit to the connecting rod the pressure produced on the piston face by the combustion or explosion of the gas charge.

Two kinds of steel are used in making piston pins—for small engines, a machinery steel case-hardened and

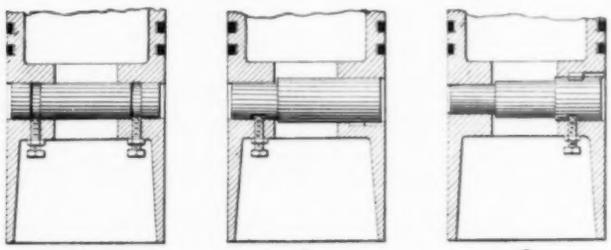


FIG. 1. TYPES OF PISTON PINS IN USE

ground; for larger engines, a high-carbon, 85-point steel, tempered and ground. Some of the taper pins for large engines are made of a nickel steel of the following composition: Ni, 3.5 per cent.; C, 0.2 per cent.; Mn, 0.65 per cent. The core of a case-hardened pin of the above-mentioned steel has an elastic limit of 150,000 lb. per sq.in. and a maximum strength of 175,000 lb. per sq.in. with a ductility of 10 per cent.

The types of piston pins used are shown in Fig. 1. *A*, a straight pin, is used in small engines up to a cylinder diameter of 8 in. The piston pin in all cases must be carefully secured in the piston bosses, and with straight pins two setscrews, locked with check nuts, are used. Type *B* shows a piston pin designed with two diameters or sizes, which provide for one end always being smaller than the central wearing portion. It is free from the defect common to straight pins which burr and wear a shoulder on the middle, making it difficult to remove the piston-pin bearing. This pin can be reground without leaving a shoulder and can always be put in or removed from the piston without readjusting the piston-pin bearing in the connecting rod. The most common method of fastening piston pins of this type is by means of a key and setscrew, as shown. At *C* is shown a similar type of pin fastened into the piston at one end by a setscrew with a locknut and a key. The advantage claimed for this method is that the other end of the pin is free to allow for changes in length due to large temperature differences. It will be noticed that this pin has three diameters and is considered a better design than either type *A* or *B*, but costs more to make. The diameter of the setscrews used for these types of pin equals 0.32, the diameter of piston-pin bearing.

For engines of 40 hp. and over per cylinder tapered pins as in Fig. 2 are used. The average taper of the pins is 1 in. per ft. The pin is provided with a key to prevent it from turning and is clamped into the piston by a nut with a ratchet, which is secured to the pin by a special pawl. Piston pins of this type are case-hardened and ground into the piston with emery and oil, making an almost perfect fit between the pins and bosses.

Piston pins are designed with two objects in view—for strength and for allowable bearing pressure, the latter being carefully considered so as to make lubrication as easy as possible.

To determine the piston-pin bearing diameter empirically the values of the cylinder diameter and the piston-pin diameter are plotted against each other in Fig. 3. The average relation for horizontal engines is expressed by the equation

$$D_{pp} = 0.0143\,D^2 + 0.7\ in. \qquad (1)$$

where

D_{pp} = Diameter of piston pin;
D = Cylinder diameter.

The average German practice from Haeder is given by the dashed curve and shows that for a given cylinder

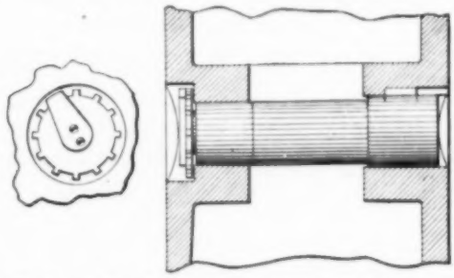


FIG. 2. TYPE OF PIN FOR LARGE ENGINES

diameter a much larger pin is used, which means a much higher factor of safety, assuming that the same material is employed for each pin.

For vertical engines the empirical relation between cylinder diameter and piston-pin diameter is given in Fig. 4 and is expressed by the equation

$$D_{pp} = 0.2\,D + 0.25\ in. \qquad (2)$$

where

D_{pp} = Diameter of piston pin;
D = Cylinder diameter.

The bearing length of the piston pin for horizontal engines is determined empirically from Fig. 5. From the

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position of the points two average curves have been drawn. Curve (a), representing the average of most of the data, gives the following relation:

$$L_{pp} = 1.4\ D_{pp} + 0.5\ in. \qquad (3)$$

and curve (b)

$$L_{pp} = 2.8\ D_{pp} - 0.7\ in.;$$

where

L_{pp} = Bearing length of piston pin;
D_{pp} = Bearing diameter of piston pin.

The average relation given in text-books on gas-engine design is that the bearing length equals 1.5 times the bearing diameter. The dashed curve in Fig. 5 gives average German practice from Haeder.

For vertical engines the average relation between piston-pin diameter and piston-pin bearing length is given in Fig. 6 and is expressed by the following equation:

$$L_{pp} = 1.82\ D_{pp} \qquad (4)$$

where

L_{pp} = Bearing length of piston pin;
D_{pp} = Bearing diameter of piston pin.

The overall length of the piston pin for horizontal and vertical engines is given in terms of the cylinder diameter in Fig. 7 and the relation is given in the equation

$$L'_{pp} = 0.95\ D \qquad (5)$$

where

L'_{pp} = Over-all length of piston pin;
D = Cylinder diameter.

The allowable maximum bearing pressure in pounds per square inch on the projected area of the piston-pin

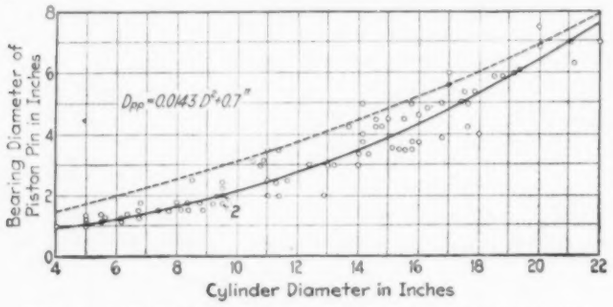


FIG. 3. PIN DIAMETERS FOR HORIZONTAL ENGINES

bearing is very high, due, first, to the great pressure on the piston face at the instant of explosion, and, second, to the short duration of this maximum pressure; and also that it occurs only for a fraction of a second every two revolutions in a four-cycle gas engine.

The wide variation of some of the points on the curves is due to the fact that engines using different fuels use a corresponding compression pressure, which means a variation in the maximum explosion pressure used in designing the machine parts subjected to the cylinder pressure. For instance, an engine using gasoline or illuminating gas has a compression pressure of from 60 to 80 lb. per sq.in., with a corresponding maximum explosion pressure of from 300 to 350 lb. per sq.in. An engine of the same size using producer gas has a compression pressure of from 120 to 160 lb. per sq.in. and a corresponding maximum pressure in the cylinder of from 350 to 400 lb. per sq.in. Therefore in Table 1 the maximum bearing pressure in pounds per square inch on the projected area of the piston pin K_{pp} has been computed from the average data on the assumption of explo-

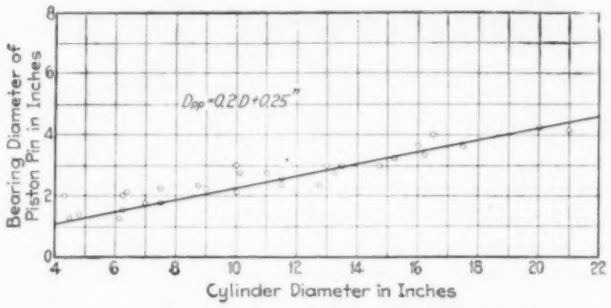


FIG. 4. PIN DIAMETERS FOR VERTICAL ENGINES

sion or maximum pressure in the cylinder of 300, 350 and 400 lb. per sq.in.

The value of K_{pp} is computed for Table 1 from the following equation:

$$K_{pp} = \frac{P_m \times \pi \frac{D^2}{4}}{D_{pp} \times L_{pp}} \qquad (6)$$

where

P_m = Maximum explosion pressure lb. per sq.in.;
D = Cylinder diameter in in.;
D_{pp} = Bearing diameter of piston pin in in.;
L_{pp} = Bearing length of piston pin in in.

The bearing pressures in Table 1 are actually not as high as computed, due to the inertia of the reciprocating parts, which is a maximum at the head end dead center

TABLE 1. PISTON PIN, HORIZONTAL ENGINES

D, in.	4	6	8	10	12	14	16	18	20	
Lpp, in.	3.8	5.7	7.6	9.5	11.4	13.3	15.2	17.1	19.0	eq. (5)
Dpp, in.	1¼	1¾	1½	2¼	2½	3¼	4¼	5¼	6⅞	eq. (1)
Lpp, in.	1¾	2¼	2⅞	3½	4¼	5¼	6⅞	7⅞	9¼	eq. (3)
App, in.	1.76	2.66	4.57	7.43	12.04	18.85	28.7	42.7	61.2	$D_{pp} \times L_{pp}$
Pm					300					assumed
Kpp	2,150	3,010	3,310	3,170	2,815	2,450	2,100	1,790	1,540	eq. (6)
Sb	7,300	8,315	8,410	7,300	6,060	4,920	4,000	3,320	2,960	eq. (7)
Pm					350					assumed
Kpp	2,500	3,520	3,850	3,710	3,285	2,860	2,450	2,085	1,800	eq. (6)
Sb	8,520	9,700	9,800	8,530	7,070	5,750	4,670	3,870	3,450	eq. (7)
Pm					400					assumed
Kpp	2,865	4,020	4,410	4,230	3,760	3,270	2,810	2,385	2,050	eq. (6)
Sb	9,750	11,100	11,210	9,750	8,080	6,575	5,330	4,425	3,950	eq. (7)

when the explosion takes place in the cylinder. The inertia of the reciprocating parts, when the engine is running at normal speed, measured in pounds per square inch of piston face is about one-fifth the total explosion pressure at head end center and of course acts in the opposite direction. Therefore all the unit bearing pressures given in Tables 1 and 2 can be reduced a fifth.

In Table 2 the values of the maximum unit bearing pressures for vertical engines of various sizes are com-

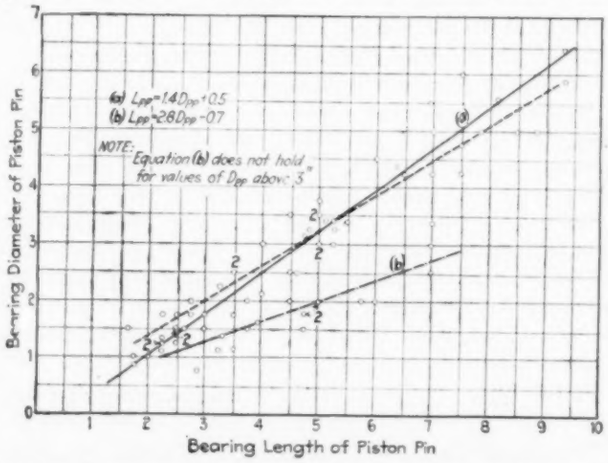


FIG. 5. LENGTH OF PISTON PIN FOR THE HORIZONTAL TYPE OF ENGINES

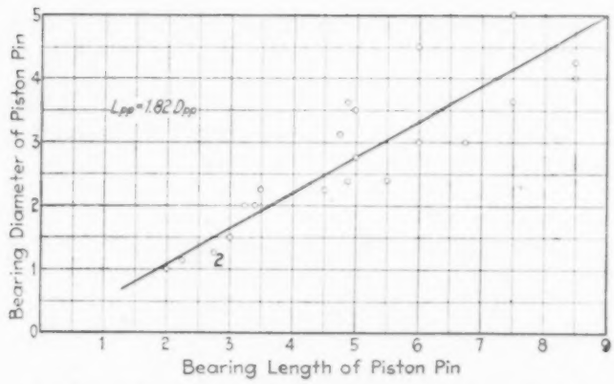


FIG. 6. LENGTH OF PINS FOR VERTICAL ENGINES

puted from the average data. German practice gives a maximum allowable bearing pressure of from 1,700 to 2,000 lb. per sq.in., and computing K_{pp} for a 12-in. and an 8-in. cylinder from the German curves in Figs. 3 and 4 for an explosion pressure of 350 lb. per sq.in., the values are 1,795 and 1,845 lb. per sq.in. respectively.

Fiber Stress in Pin

In considering the maximum unit fiber stress (S_b) in the pin, the piston pin is considered as a uniformly loaded beam fixed in the piston-pin bosses. The values for S_b

TABLE 2. PISTON PIN, VERTICAL ENGINES

D, in.	4	6	8	10	12	14	16	18	
Lpp, in.	3.8	5.7	7.6	9.5	11.4	13.3	15.2	17.1	assumed
Dpp, in.	1 1/16	1 5/16	1 11/16	2 1/16	2 7/16	2 13/16	3 3/16	3 9/16	equation (2)
Lpp, in.	1 1/2	2 1/16	3 1/16	4 1/16	4 7/16	5 1/16	6 1/16	6 13/16	equation (4)
App., in..	2.06	3.78	6.00	9.16	12.48	16.86	21.50	26.45	Dpp × Lpp
Pm					300				assumed
Kpp	1,835	3,245	2,510	2,570	2,720	2,740	2,810	2,890	equation (6)
Sb	5,180	6,380	7,110	7,120	7,560	7,520	7,890	8,120	equation (7)
Pm					350				assumed
Kpp	2,135	2,620	2,930	3,000	3,170	3,200	3,270	3,370	equation (6)
Sb	6,030	7,450	8,300	8,315	8,800	8,780	9,200	9,460	equation (7)
Pm					400				assumed
Kpp	2,445	2,995	3,350	3,430	3,620	3,650	3,740	3,850	equation (6)
Sb	6,900	8,520	9,490	9,500	10,800	10,300	10,520	10,820	equation (7)

for the various cylinder sizes and for explosion pressures of 300, 350 and 400 lb. per sq.in. for both horizontal and vertical engines are given in Tables 1 and 2 respectively. The following sample computation is made for a 35-hp.

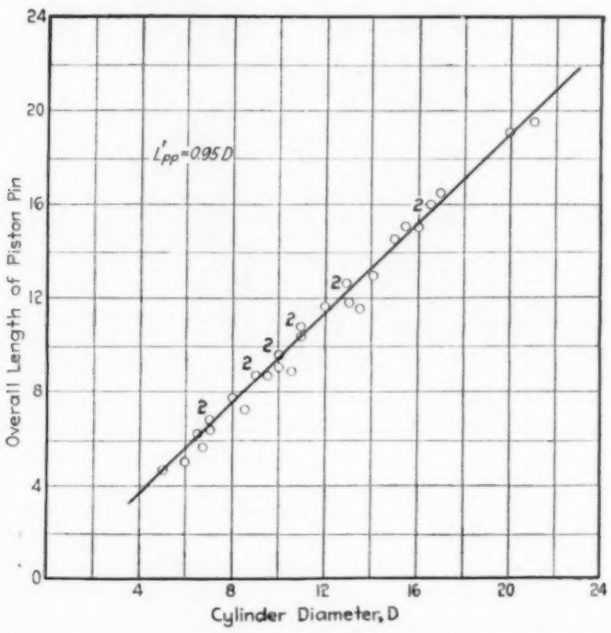


FIG. 7. LENGTH OF PIN FOR HORIZONTAL AND VERTICAL ENGINES

TABLE 3. EQUATIONS FOR PISTONS, PISTON PINS AND RINGS

	Horizontal Engines	Vertical Engines
D = Cylinder diameter		
L_p	1.55 D − ¾ in.	1.72 D − 2 1/16 in.
Dist. a	0.56 L_p	½ L_p + 1 ¼ in.
T_{pf}	0.075 D − ¼ in. (unwebbed)	0.13 D − ¼ in. (webbed)
T_{pb}	0.035 D	
T_w	0.027 D + 0.1 in.	
b	1.4 T_{pb}	
c	0.085 D	
No. of rings	4 to 6	
D_{bf} = Diameter of ring blank	$\frac{1.03\,D}{0.24\sqrt{D-3}}$ in.	
W_r		
D_{r-r}	$W_r + \frac{1}{4}$ in.	
Tr max.	0.021 D + 0.1 in. (concentric rings)	
Tr max.	0.026 D + 0.1 in. (eccentric rings)	
Tr min.	0.637 Tr. max.	
Dg	Tr max. + 1/32 in. to 1/16 in.	
Dpp	0.0143 D^2 + 0.7 in.	0.2 D + ¼ in.
Lpp	1.4 Dpp + 0.5 in.	1.82 Dpp
L'_{pp}	0.95 D	
Dppb	1.65 Dpp	
Taper of pin	1 inch per foot	

gas engine of a horizontal type with a cylinder diameter of 12 in. From Fig. 8 the maximum moment for a beam with both ends fixed and the load uniformly distributed equals $\frac{1}{12}\ W \times L_{pp}$, where

W = Total load; and

L_{pp} = Bearing length of pin.

Example:

$P_m = 350$ lb. per sq.in. assumed;

$D = 12$ in. cylinder diameter;

$D_{pp} = 2.75$, Equation (1);

$L_{pp} = 4.375$, Equation (3);

$$W = P_m \frac{\pi D^2}{4}$$

$$\therefore \textit{Maximum bending moment} = M_b = \tfrac{1}{12} \times 350 \times \frac{\pi \times 12^2}{4} \times 4.375$$

$$M_b = 14{,}470\ in.\text{-}lb.$$

but

$$M_b = \frac{S_b I}{e}$$

where

$$\frac{I}{e} = \frac{\pi D'^4_{pp}}{64} \times \frac{2}{D_{pp}} = \frac{\pi D'^3_{pp}}{32}$$

$$\therefore S_b = \frac{M_b \times e}{I} = \frac{14{,}470 \times 32}{\pi \times 2.75^3} = 7070\ lb.\ per\ sq.in. \quad (7)$$

In German practice the piston pin is considered as a uniformly loaded beam supported at the center of each boss. This of course gives a longer beam and a correspondingly higher fiber stress, so that the allowable maximum unit stress given by Haeder and Güldner is from 11,000 to 13,000 lb. per sq.in.

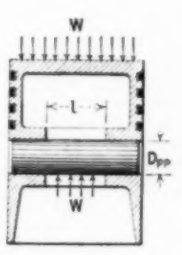


FIG. 8. MOMENTS ON A PISTON

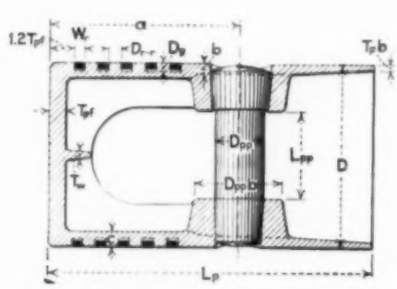


FIG. 9. DIMENSIONS OF PISTON PIN

The diameter of the piston-pin boss expressed in terms of piston-pin diameter is given in the following equation:

$$D_{ppb} = 1.65\, D_{pp} \quad (8)$$

where

D_{ppb} = Diameter of piston-pin boss;
D_{pp} = Diameter of piston pin.

German average practice from Haeder gives

$$D_{ppb} = 1.79\, D_{pp} \quad (9)$$

Table 3 gives the empirical equations for determining the dimensions of pistons, piston pins and piston rings for horizontal and vertical engines using gasoline, illuminating gas, natural gas and producer gas as fuel. The dimensions corresponding to equations in Table 3 are given in Fig. 9.

Care of Pneumatic Tools*

By August Meitz†

In handling pneumatic tools several points are to be taken into consideration. First of all, it is a good policy to adopt a standard of such tools on any one railroad system. This plan would reduce the cost of repairs and maintenance about 50 per cent. as well as reduce the expense for repair parts to be carried in stock in order to expedite repairs and to prevent holding tools out.

In selecting pneumatic tools for service a great many mistakes are made by the workmen as regards to speed and power. For instance, an air motor of high speed will be used by a boiler maker to drill out stay-bolts; and as soon as he has completed this drilling, he will use the same motor for running in a stay-bolt tap, say $1\frac{1}{16}$ in., thereby using the same speed as he had just used on a $\frac{3}{4}$-in. high-speed drill. In such cases damage is done to the motor as well as to the tap—the motor is overloaded and the tap is overspeeded, with the result that the motor will break in some place and the tap is spoiled. The same result is had by drilling and reaming at too high speed on the motor—the reamer is spoiled. Taking the standard rule, "What is gained in speed is lost in power," we come to the conclusion that it is unwise to have all high-speed motors in any one shop, as the little time gained by drilling is a double loss on spoiled drills and taps which, if handled in a more reasonable manner, would pay for the lost time.

All motors should be kept clean and well oiled at all times. Good engine oil should be used, and it will also be found to pay to use some light grease to fill the case or crank chambers.

Air hammers should always be well oiled before using. A light mineral oil, we have found, gives best results. Any oil which will gum or thicken in cold weather should be avoided. After a hammer has been in service and returns to the toolroom, it should be placed in a solution of gasoline and signal oil, equal parts, as small particles of rubber from the hose lining frequently lodge in the chamber between the handle and the throttle-valve sleeve. The gasoline mixture will cut this rubber, and by blowing out the hammer with compressed air, all refuse and foreign substances are removed. After the hammer has lain in the oil about five minutes, it should be taken out and hung up to drip. Before the hammer is used again, all parts should be properly oiled.

Others find that if air hammers are kept in a coal-oil bath when not in use, there is very little repair work to be done on these tools until some part becomes worn so that it must be replaced by a new one.

The throttle handle of the motor is filled with coal or signal oil every evening, which prevents throttle valves from sticking and also keeps the valves of the machine clean; both give more or less trouble when neglected.

*From American Railway Tool Foremen's Association Proceedings.

†Tool foreman, Missouri, Kansas & Texas Ry., Parsons, Kan.

Making Steel Filing Cabinets with Oxyacetylene Torch

Editorial Correspondence

The oxyacetylene welding torch is now entering quite extensively into the manufacturing of steel furniture. In this article methods used by the Shaw-Walker Co.,

FIG. 1. WELDED FILING CABINET

Muskegon, Mich., when making steel filing cabinets will be illustrated.

One of the finished vertical filing cabinets is shown in Fig. 1. It is composed of four drawer sections each of which measures $10\frac{1}{2}$ in. high by 12 in. wide by $25\frac{1}{2}$ in. deep. The dimensions of the cabinet as assembled are $13\frac{7}{8}$ in. wide by 27 in. deep and 52 in. high. The

drawers and casing are made from No. 18 gage steel. In making this cabinet eight corner welds are made, and the time occupied is approximately 30 min.

Using a No. 2 tip, the amount of gases consumed is 2¾ cu.ft. of oxygen and 2½ cu.ft. of acetylene. It has been found advisable, to facilitate the welding, to electric spot weld many of the elements. In Fig. 2 is shown an electric machine spot welding one of the cabinet elements prior to flame welding.

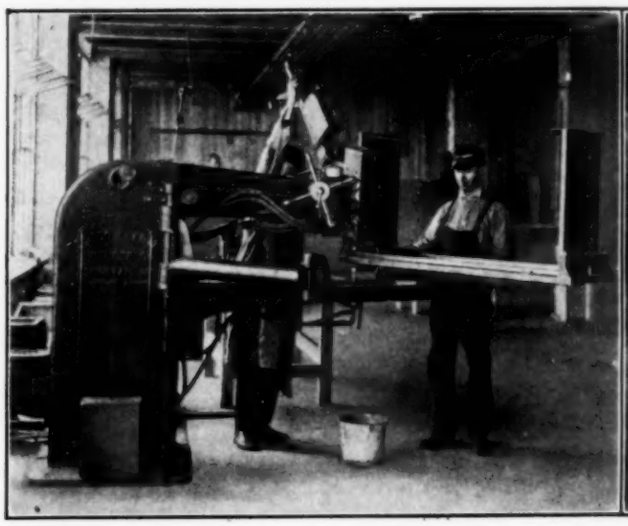


FIG. 2. SPOT WELDING THE SECTIONS

FIG. 3. FLAME WELDING A CASING

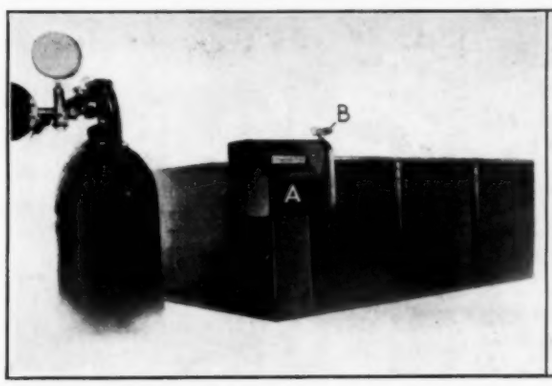


FIG. 4. FIXTURE FOR WELDING CORNERS

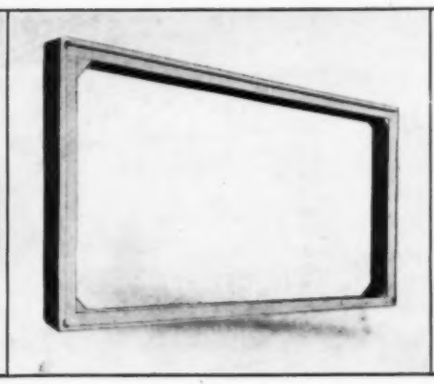


FIG. 5. A WELDED CABINET BASE

FIG. 6. A WELDED CABINET TOP

Welding Corners of a Cabinet Casing

The operation of flame welding the corners of a cabinet casing is shown in Fig. 3. After the elements have been spot welded, the corners are flame welded. The advantage of the previous spot welding is that the elements are held securely, and the joint may be finish welded quicker and with a smoother appearance.

Sometimes it is found an advantage to hold the plates when making the corner welds. For this purpose a fixture, shown in Fig. 4, was devised. The cast-iron block *A* is fastened on the corner of the cabinet with the clamp *B*. The block is made with a slot, as shown, so that the flame may be fed as near to the metal as desired and a neat weld made. This cabinet section is made from No. 20 gage steel and is 12 in. wide by 10½ in. deep by 25 in. long. When welding the four corners the time required is 1 min.; and using a No. 1 tip, 0.058 cu.ft. of oxygen and 0.054 cu.ft. of acetylene gas are consumed.

In Fig. 5 is shown a base used on a horizontal section which has been welded. This part is made from No. 16 gage steel, and miter welds are made at each corner. The time occupied is 20 min., and the amount of gases consumed is 1.81 cu.ft. of oxygen and 1.76 cu.ft. of acetylene.

One of the tops used on the horizontal sections is shown in Fig. 6. It is made from No. 20 gage steel, and the four corners are welded, taking approximately 2 min. For this work a No. 1 tip is used, and the gases consumed are 0.116 cu.ft. of oxygen and 0.108 cu.ft. of acetylene. The apparatus was made by the Davis-Bournonville Co.

A Brazilian Railroad Shop

Special Correspondence

Railroad men in this country will be interested in the illustrations from the shops of the Central Railroad of Brazil, at Eughenio De Dentro. It is indeed difficult to realize that the building in Fig. 1 is the entrance to a railway repair shop, but such is the case. Only the truck wheels in front link it up in any way with railway-shop work.

Inside, however, it has a very shoppy appearance. Fig. 2 shows a section of the foundry, and Figs. 3 and 4 are two views in the erecting shop. This, as will be seen, is well equipped with traveling cranes made by the Niles Co. These views give a good idea of the size of

A BRAZILIAN RAILWAY SHOP EQUIPPED WITH MODERN MACHINE TOOLS OF AMERICAN MANUFACTURE

Fig. 1—The front of the building. Fig. 2—In the foundry. Fig. 3—Transferring a locomotive by overhead crane. Fig. 4—Another view in the erecting shop. Fig. 5—The machine shop used for small work. Fig. 6—In the wheel shop

the locomotive used, as well as of some of the shop appliances.

In Fig. 3 will be seen the substantial laying-out tables in the foreground. They are mounted on brick piers. The sanitary drinking fountain is also very much in evidence, beneath the cab of the suspended locomotive. Fig. 4 shows a type of small, square work-bench that seems to be distributed between the erecting tracks for the benefit of the workmen. Both these views give a good idea of the type of shop construction used in Brazil, the side windows and skylight apparently affording an adundance of light and air.

A view in the machine shop is shown in Fig. 5, this shop being supplied with a traveling crane on the track in the aisle at the left. The manner of suspending the line shaft down the aisles and the method of belting from it to the various countershafts are shown. Fig. 6 gives a view of the wheel shop, which is supplied with a 10-ton Whiting crane.

It is interesting to note that nearly all the machinery in these shops comes from the United States, a large percentage of it being supplied by the Niles-Bement-Pond Co. Those who are interested in extending their trade in this direction can secure a good deal of the kind of machines needed and to some extent, of the conditions to be found in the average shop in this part of the world. As will be seen, most of it is general rather than special machinery. These photographs are from our own correspondent, Duncan C. Hood.

Letters from Practical Men

High-Speed Steel Taps for Iron Fittings

The use of high-speed steel taps in the manufacture of gray and malleable-iron fittings has enabled manufacturers to reduce their machining cost considerably.

In a series of tests at a large fitting plant it was found that high-speed steel tap blades should be hardened and drawn in a different manner from most high-speed cutting tools. Several brands of steel were used in these tests, some showing greater life than others, and all of them, when properly treated, tapping from 28 to 40 per cent. more holes at one sharpening than did carbon-steel taps of the same construction. This work consisted of tapping rough-cored holes only in gray and malleable castings at surface speeds ranging from 50 to 55 ft. per min. The best results were obtained with a high-speed steel hardened in a good grade of lard oil at approximately 1,900 deg. F. and the temper drawn to as high as 750 deg. F. On some of the smaller sizes in which the blades had to be made quite small, measuring approximately $\frac{7}{32}$x$\frac{1}{2}$ in. in cross-section, the best results were obtained by drawing the temper to a heat that would quite thoroughly anneal a carbon blade.

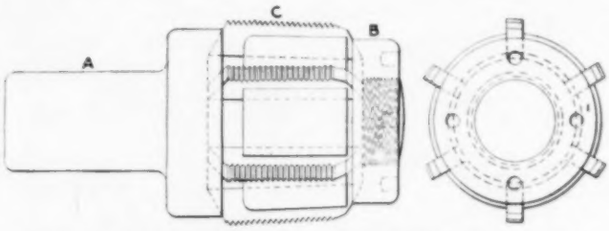


FIG. 1. SOLID ADJUSTABLE INSERTED-BLADE TAP

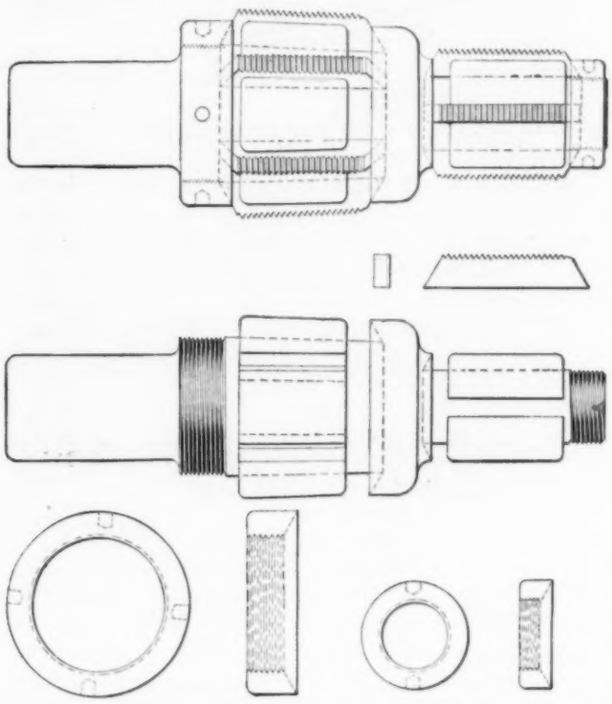


FIG. 2. TWO SOLID ADJUSTABLE INSERTED-BLADE TAPS

Thin blades have to be drawn to a very dark-red heat before the crumbling up of the threads can be eliminated. Another curious thing that was discovered on automatic tapping machines before they were speeded up for high-speed steel was that the new high-speed taps in some cases did not show any more production per sharpening than did the old carbon taps. It was only after having speeded up the machines to nearly twice the old speeds that the high-speed taps showed their superiority by tapping from 28 to 40 per cent. more holes per sharpening.

The cutting lubricant used in this plant is composed of three parts soft soap and one part lard oil boiled in water for ½ hr. and distributed throughout the plant by a centrally located pumping system. It is used freely on all metal cutting.

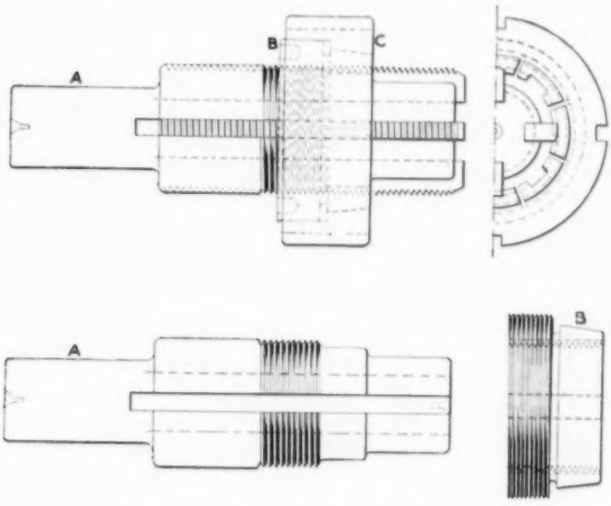


FIG. 3. INSERTED-BLADE HIGH-SPEED TAP

In Fig. 1 is shown a high-speed, solid, adjustable inserted-blade tap designed to be made in sizes from 1 in. up. It is not very expensive, is very rigid and accurate and can be adjusted easily by placing thin strips of metal under the blades. The beveled-face nut *B* forces the blades down upon their seats with equal pressure. This nut is made of hardened steel and the body *A* of a low-grade tool steel left soft, so that a slight cut can be taken in a lathe across the beveled shoulder *C* should it require truing up. This is an extremely rigid adjustable blade tap and gives good service. Fig. 2 shows the same construction of tap made in two sizes, designed for tapping electric-light pole couplings at one operation. These couplings are tapped for 2½-in. pipe at one end and 4-in. pipe at the other, from the rough casting. When tapped formerly in two operations at two different settings, it was difficult to tap the holes in line with each

other. The large tap was made tapering, but the small one, being run in from the back end of the hole, had to be made straight. The small hole, which is tapped straight, makes no difference in the joint in this case. This double tap lowered the machining cost 75 per cent. on these couplings and eliminated an expensive straightening operation on the poles that was necessary when the couplings were tapped from each end at two different settings of the work.

In Fig. 3 is shown an inserted-blade, high-speed tap designed for tapping standard pipe fittings in large quantities on special semiautomatic tapping machines. Its great advantage is the long life of the tap body, since it can be sharpened by grinding off the ends until fully half their length has been ground away. *A* is the body, which for hard usage should be made of low-grade hardened tool steel. It has radial cutter slots milled across the body and is threaded to the same diameter as the tap cutters, to fit the collet *B*. The collet *B* has clear-

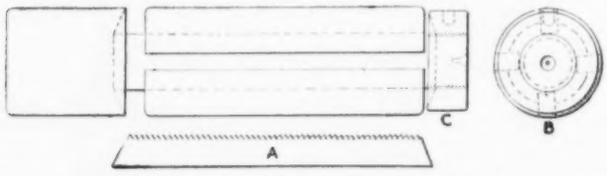


FIG. 4. MASTER HOLDER FOR THREADING TAP CUTTERS

ance slots in its threaded hole, as shown in the end view of Fig. 3, which allows it to be slipped on the tap over the cutters to the position shown. The collet *B* is then given about one-eighth of a turn, as shown in the end view at Fig. 3, and held in place with a spanner wrench while the threaded collet ring *C* is tightened upon it, thereby securely locking the jaws of collet *B* against the cutters. This collet and collet ring are made of hardened tool steel.

In Fig. 4 is shown a master holder used for threading the long tap cutters shown at *A*. The cutter slots are milled at a slight angle with the center line as shown at *B*, so that when these cutters are mounted in the radial slots of the working holder *A*, Fig. 3, the tap will have eccentric relief on its threads. The beveled-face nut *C* secures the long cutters in the slots for threading them. It is apparent that if this nut were made very tight, the cutters, owing to their great length, would spring up slightly in the center. These cutters, if properly fitted to the slots, are held securely by a very slight tightening of the nut. A. J. CHAMBERLAIN.

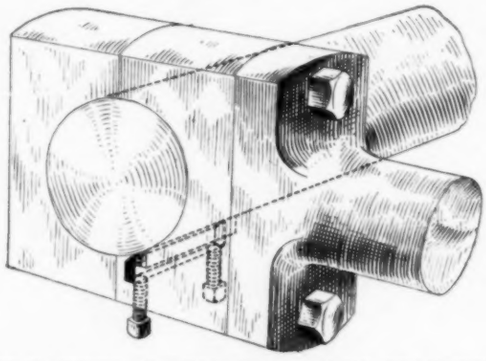
South Bend, Ind.

Improvised Method of Turning a Scored Crankpin

A few months ago the 65-hp. heavy-duty gas engine in the tug "Miraballes" belonging to a steamship company developed a badly scored crankpin. We found that it would mean taking the whole engine down to get the crankshaft out, and that our lathe was too small to take it.

As a hurry-up job was required, I decided to make a box tool out of the crankpin bearing box. As shown in the illustration I chipped a groove ¼ in. wide and ⅞ in. deep in the upper half of the box. In this groove I inserted a cutter the length of the bearing and a snug fit in the groove. This cutter was made out of a file, the cutting edge being finished on an oil stone and raked about 20 deg. I took great care to get the cutting edge perfectly straight. Four holes were then drilled and tapped back of the cutter, and $\frac{3}{16}$-in. setscrews inserted in them, to feed the cutter toward the center of the box. A space ⅜x⅜ in. was also chipped above the cutting edge to make room for chips.

The box was assembled on the crankpin, the setscrews set up evenly to take a very light scrape (rather than cut) and the engine barred over by hand two turns. The box was then taken apart, chips cleaned out and the operation repeated. This was done several times until the pin was smooth. The last chip taken out was in one piece and resembled a roll of tissue paper. The surface of the crankpin was then further smoothed up by removing the cutter from the box and assembling the box with



IMPROVISED METHOD OF TURNING CRANKPIN

a piece of fine emery cloth bent double to have the rough touching both the box and the pin.

The crankpin box was afterward bored out ¼ in. in the lathe and babbitt metal cast in it, which of course filled up the cutter groove and chip space. The box was finished in the lathe to the new size of the crankpin. This repair has since given absolutely no trouble from the bearing heating or otherwise, and has stood up to the work very well. J. G. SAXE.

Puntarenas, Costa Rica.

Bending Small Tubes Without Rosin Filling

Steel, brass and copper tubes from ¾ to ½ in. in diameter, if bent without filling, do not hold their cylindrical form but flatten; and the thinner the wall of the tubes the more this flattening occurs. To overcome this change in shape, it is common to fill these tubes with melted rosin, which prevents collapse or distortion of the tube; but the rosin has to be melted out after the tube is bent. It is difficult to get it all out, and the job is a messy and expensive one.

A better way is to use a closely wound spiral spring, rolled up from a small-diameter wire. This spring must enter just nicely into the tube, but the whole trick after bending the tube is to withdraw the spiral spring. It can be done as follows:

A plug of three or four diameters in length must be fitted inside the spring, which should extend outside the bent tube about an inch or a little more. The spring with the plug in it should then be clamped in a lathe chuck. Revolving the lathe in a direction which will

wind up the spring, at the same time pulling on the tube, withdraws the spring easily, and a good job is readily made of the bending.

Some experiments have to be made to get the size of wire and its temper just right. Should the spring be too highly tempered, it is apt to break; if a too large diameter of wire is used, it will be difficult to withdraw, while if it is left too soft, it will stretch in pulling out and have a permanent set. Generally speaking, a small diameter of wire is preferable; and it is always well, in fact necessary, to lubricate the spring. Albany grease or vaseline will be found preferable to oil.

New London, Conn. A. R. NEMOUR.

Reaming Fixtures for Pistons

In Fig. 2 is shown a fixture used by the International Motor Co., Saurer Plant, Plainfield, N. J., for line-reaming pistons. The piston is placed on the inside of the fixture, which is bored to receive it. The reaming bar

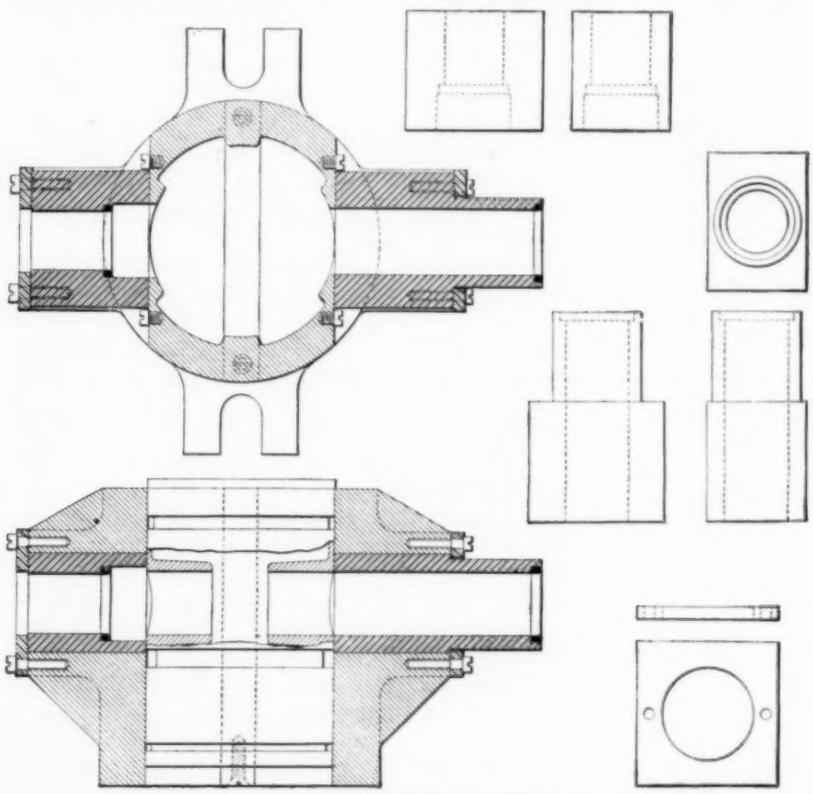


FIG. 1. DETAILS OF LINE-REAMING FIXTURE

is then placed in position, being guided in bushings on each side of the fixture. It will be observed that the bar is provided with oil grooves to prevent any seizing when the hole is being reamed. Turning motion is obtained on the bar by means of a wrench on the squared end. The fixture is fastened on a table as shown to hold it during the operation.

Details of the fixture are shown in Fig. 1. It will be noticed that the bushings are carried in supports. These are made loose and attached to the fixture. By this method different sizes of bushing may be used.

New York, N. Y. A. TOWLER.

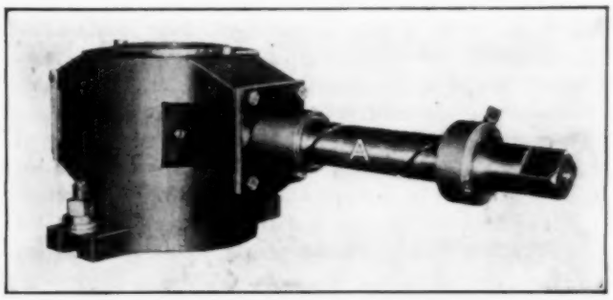


FIG. 2. LINE-REAMING FIXTURE

Use of Micrometer Collar on the Crossfeed Screw

Considerable attention has been given the lathe—its construction and the work that can be done with it—but it seems as though one little part has been forgotten and is not clearly understood by lathe hands, that is, the micrometer collar on the cross and compound-rest screw. To most operators this collar is there and marked just to remember easily where to start when cutting a thread. For an example to illustrate the use of the collar, take a ⅕-pitch crossfeed screw with a micrometer collar of 100 lines to the circumference. Divide the pitch by the number of lines on the collar. The quotient is the value of each line; ⅕ pitch = 0.200, $\frac{0.200}{100} = 0.002$, which equals 0.004 on the diameter. Now let us put a ¼-in. ball groove 3¼ in. in diameter in a 3-in. bore; 3¼ — 3 = ¼ = 0.250. Dividing this difference by 0.004, or simply 4, gives the number of lines to feed in with the grooving tool; $\frac{0.250}{4} =$ 62½ lines. Now touching the 3-in. diameter lightly with the tool, feed in 61½ lines, and no inside caliper will be needed. To most lathe hands the job of cutting a thread in the lathe is a hard one. We find them taking the piece in and out of the lathe, trying to fit a standard nut sometimes at half the depth of the thread. Let us take for an example a ¾-in. U.S.S. nut to be fitted to a shaft. The shaft is turned 0.010 small; ¾ U.S.S. = 10 threads. Ten threads constant equal 0.12990; 0.12990 — 0.010 = 0.11990, and 0.11990 ÷ 4 = $\frac{0.11990}{4} = 29\frac{9}{10}$ lines. We then proceed to cut the thread in the same way as described.

HARRY F. KIENKER.

Cincinnati, Ohio.

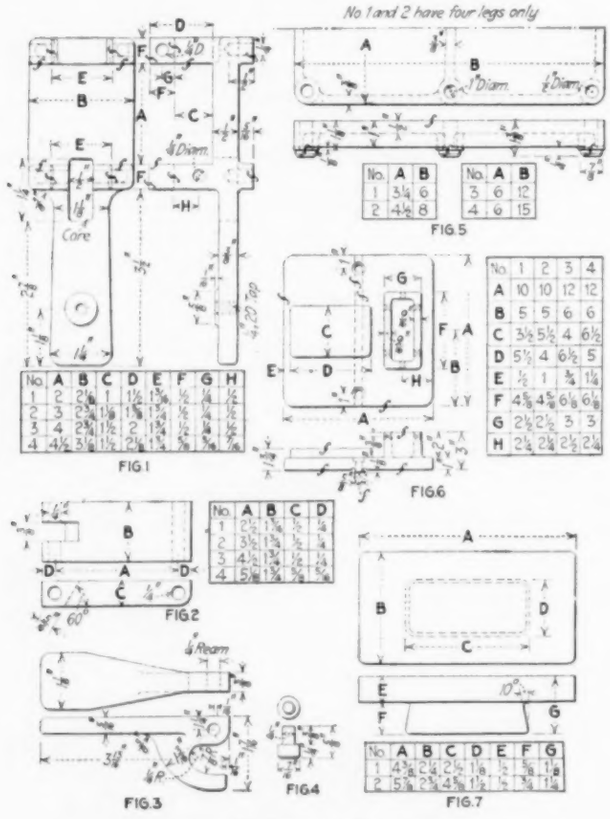
Jig and Fixture Standards

The standardization of jig and fixture design has been given more attention during the past few months than ever before and it is hoped that the question will be agitated further.

It is with this idea that this set of standards has been tabulated and shown in this article.

There are many styles of vises that can be purchased that will hold parts for milling operations by designing special jaws or by taking cuts on regular jaws. The bases for drill jigs are tabulated and illustrated in Fig. 1. These bases are castings. The figure C is ample to cover almost all cases and yet leave space for a tool-steel locating plate and for suitable clamping devices.

The standard leaf for each jig is shown in Fig. 2. This part is made of tool steel spring tempered and machine steel carbonized, reheated and hardened and then ground on top and bottom and both sides. The tempered half is used where clamping only is done by the leaf; but



JIG AND FIXTURE STANDARDS

where the leaf is used to guide the drill or reamer, the machine-steel leaf is employed. The clamping handle, a tool-steel drop forging hardened, is shown in Fig. 3, while Fig. 4 shows standard tool-steel legs hardened, the ends of which bear on the drill table. They are ground after being forced in place true with the finished surface of the jig, upon which the locating block is placed.

A flat-plate jig is shown in Fig. 5, which is suitable for irregular-shaped pieces or parts too large to go in any of the other standard jigs. These jigs are ground on the top, turned over and ground on the big bosses and the holes for the legs drilled and reamed. The legs are forced in and ground on the ends, the same as the other jigs. These bosses are left in stock in this shape and when it is desired to make a jig from this base, any slots or holes may be machined to suit the conditions of the work. Where possible, standard leaf and handle parts are used from the other jig and flat handles are applied in convenient places to facilitate handling.

Profiling bases are shown in Fig. 6. These bases are cast iron. The work is clamped or held in special vises to the large finished pad indicated by dimensions *C* and *D*, while the adapter of Fig. 7 is fitted on the other pad with the cored portion. Six square-head machine screws are used to adjust the adapter, upon which is screwed and doweled the former plate in correct relationship with the piece to be profiled.

This same base may be used for several different jobs, and a new base may be used for each operation, depending on the time taken to produce the cuts.

Providence, R. I. M. S. WRIGHT.

Efficiency in Checking Tools Out of the Crib

In many shops in which I have worked, the tools were checked from the tool crib through a window. Generally this window is just about wide enough for one man to move his arms comfortably around while getting his checks out, looking at the tools offered, etc. It is close quarters for two and a tight squeeze for three to obtain a hearing.

The result is that while the one or two able to be at the window are explaining what they want, examining what they get, demanding something else, changing their minds, or discussing last night's experiences, quite a few are waiting back of them for a chance to get near enough to the window to do business. This operation is repeated over and over again every day.

Obviously there is time lost to the firm as well as a real annoyance to those who are truly interested in their work. The best remedy that I have ever seen is to substitute a counter for the window and have it long enough to accommodate at least six men. Then the crib attendant can go from one to another while each man is making up his mind or examining the tools. I do not claim originality for this plan, but I do fully appreciate its value under practical conditions.

Another idea to which I have given considerable thought and which is original so far as I know, is to issue tool checks of varying value, especially to the tool makers. In one of the finest shops I ever worked in, each tool maker received 25 checks. In the tool crib were kept all needed supplies, even to bolts, straps, counterweights, etc. A man with his 25 checks could at once secure all the tools required, even down to bolts in any length desired, varying by ½ in.

Of course this system makes it possible for each man to have out 25 tools of more or less value. Most shops could not and would not stand this expense. Therefore the usual allotment of checks is from 6 to 15. Such a regulation does not permit a man to have out many tools at a time. Even if auxiliary tools such as bolts, straps, etc., and parts as necessary as the height gage or indicator in boring a jig, for instance, were kept in the crib, he would have difficulty in securing them, because he would not have checks enough to go around under the arrangement mentioned.

To overcome this difficulty I would suggest issuing to each tool maker say 6 checks of a fixed shape—each one good for any tool in the crib. I would also issue perhaps 15 checks of a different shape and of a limited value—good only for such auxiliary equipment as I have mentioned. CHARLES F. ROGERS.

Springfield, Mass.

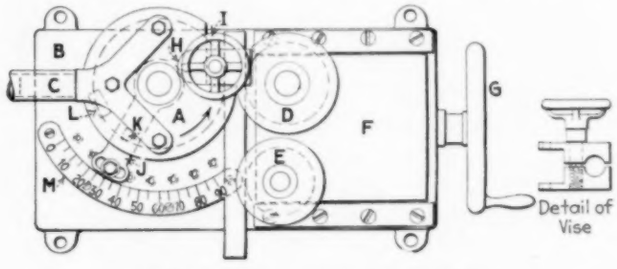
Discussion of Previous Question

Fixture for Bending Tubes

The tube-bending device described by F. C. Mason on page 1040, Vol. 43, reminds me of one which I designed recently. As it proved successful, a description of it may be of interest.

Referring to the illustration, *A* is the main forming roll. It is mounted on the base *B* and operated by means of the handle *C*. At *D* is shown a supporting roll the principal function of which is to prevent the tube from flattening, while *E* is the guide roll. Both are mounted on the slide *F*, which is attached to the base and operated by the handwheel *G*. The slide is for the purpose of adjusting the rolls and also to facilitate the removal of the work; but in most cases it was not found necessary to use it for the latter purpose.

The rolls *A* and *D* are cut away to make room for the vise *H*, which is mounted on *A* and operated by the small handwheel *I*. The jaws of the vise are bored to



FIXTURE FOR BENDING TUBES

the size of the tubing to be bent and are so located that they are a continuation of the groove in the forming roll and tangent to it. When the handwheel is released, the jaws are opened by means of springs (not shown).

The swinging arm *J*, which is pivoted on the boss supporting the roll *A*, is provided with a stop *K* that engages with a stop *L* on the roll. By means of this arm and the protractor *M* the machine can be set accurately to any desired angle within its range.

This fixture was used for bending 1¼-in. No. 14 gage seamless steel tubing with a radius of 4½ in. The bends ranged from a few degrees to 90 degrees.

Lansing, Mich. F. R. CONNER.

Suggestions from Employees

The editorial on this subject, on page 1001, Vol. 43, points out many of the defects of the suggestion-box scheme, tells why it works for a time and then just naturally peters out. I believe the editorial shows the case exactly as it is, but I still believe the scheme a good one and that it can be made to work if there is an attempt to follow out some of the first principles of fairness, as suggested.

The paying of a fixed and usually inadequate premium will attract for a time only, until the accumulation of ideas is exhausted. No firm pays a fixed price for patents it buys, from an outsider at least, but pays in accordance with their value to the firm. Some may be dear at $100 and others cheap at $100,000. In the same way, ideas from employees should be paid for according to their value to the company. And while the exact value may be hard to determine, a fair approximation can be had with a little care and a little more tendency to take men into the confidence of the firm and a little less of the old, autocratic, "this is solely my business" attitude.

If a suggestion saves a half-hour a week, no man would expect a very heavy reward, even though this counts up to about a month in five years. But if the suggestion cuts the labor in half on a piece that is made day after day, it is very evident that a $5 or a $10 reward is wholly inadequate. A small sum at adoption and a monthly bonus of a portion of the savings as these savings accumulate ought not to be difficult and would make a reward that would be well worth while.

As a matter of strict justice this monthly bonus should continue as long as the idea saves money for the firm, whether the man continues in its employ or not, especially as a pension to his widow or heirs. But aside from this, even the continuance of the bonus during employment would make for longer terms of service and help to promote good feeling.

I believe the suggestion box can be worked to mutual advantage, but it will not run itself. It requires a careful consideration of the rights of the suggester as well as those of the firm. The men themselves can be depended on to play fair if they are met with a similar attitude. FRANK C. HUDSON.

New York, N. Y.

Ribbed Glass for Shop Windows

The statement on page 1086, Vol 43, by Professor Sweet, in favor of ribbed-glass windows for shops is not convincing, as it merely shows that the glass area in that particular shop was sufficient for pattern work, the windows being high enough to admit light into the interior of the room. But pattern work does not require as much light as machine work; hence a satisfactorily lighted pattern shop might make a very inadequately lighted toolroom, especially where die work has to be done.

Furthermore, Professor Sweet's contention carries less weight, because plain-glass windows had not been tried in that particular shop. Let him remove the ribbed glass from one window and note the improved illumination of the area served.

I have worked in three shops that had ribbed-glass windows and know from actual experience, and have the testimony of others, that the light in those shops was very unsatisfactory as regards volume and quality. Within the past year I have seen the ribbed wire glass of the lower sashes of the windows in one shop removed,

at great expense, and replaced with transparent wired glass. The shop is high above surrounding buildings, and the window area is immense, yet the light was unsatisfactory in the interior and at the benches close to the windows.

One of the head men in the concern told me he used to think the complaints of the men regarding light were uncalled for, that they were "kicking" on general principles. One day he tried to do a fine piece of work and found he could not see to do it until the ribbed glass was removed. This experience convinced him that the complaints against the glass had a good foundation. After the change had been made to plain glass for the lower sashes in this shop, many men noted with astonishment the great improvement in the volume and quality of the light.

I grant that there is greater uniformity in the illumination of different areas in shops that have ribbed-glass windows. There is no more light in any particular area than there would be with plain glass, but the benches near the windows have been robbed of the light which has been projected into the interior. The total volume of light in the shop is much less than with plain glass, especially when the ribbed glass gets a little dirty. The amount of light "stopped off" by the ribbed glass can be judged by taking a small pane of it to various parts of the shop and noting the shadow cast by it. The uniformity of the illumination deceives some people into believing that the light is good. The eye gets used to the gloom, the iris expands, and it is only when doing fine work that the brain becomes conscious that the eye is struggling in semidarkness.

Some men working behind ribbed glass object to the windows being cleaned. They say the light, especially when the sun shines square against the glass, hurts the eyes. We even find the windows painted white and tracing paper stuck on it to cut off the glare. Surely when men perform such stunts as these, which cut off still more light, the objection they have to ribbed glass is not all imaginative.

There is in Brooklyn a series of buildings devoted to various industries, some requiring much light and others very little. It is very noticeable that the old buildings have ribbed and the new ones plain glass. It looks very much as though the ribbed glass had been tried and found so unsatisfactory that it was finally decided to abandon it.

F. J. BADGE.

Brooklyn, N. Y.

Machinist Instruction in the Public-School System

Some valuable suggestions have been brought out under the above heading. I have had some of my seemingly difficult problems solved. I should like to reënter the discussion at this time to comment on what has been written and to seek further light on the subject.

It seems to me that Mr. Turbon hits the nail squarely on the head in his criticism of Mr. Kreider's methods of instruction. To my mind there is absolutely no room in the vocational-school course in this stage of development for scrap-heap exercises. The vocational movement is growing. More schools will be started, and they will need equipment, part of which might just as well be designed and built in the schools now in operation.

Some will protest that such work is beyond the boys' ability, but I believe, if the scheme suggested by Mr. Turbon on page 958 is followed, almost any of the ordinary machine tools within the capacity of the school's equipment can be built. We have carried out this idea for the past two years with good results. Very often it is necessary for the instructor to make the final adjustments for the finishing cut on an important part, if the machine is to be carried on to completion. This fact should not eliminate the machine as a school product, but should be a legitimate part of the instructor's work.

The time element in school work is one point on which I wish additional light. There are some here who think that time should not enter into the school work at all, believing that if a certain time is set on a job the boy is very apt to spoil his work in an effort to approach the estimated time; they also believe that it is better to turn out a first-class job in six weeks than to scrap it in ten minutes. I am not sure whether or not they considered future attempts.

Personally I believe that quality should be the foremost consideration, but the time element should always be present. The more a boy does, under adequate instruction, during the course the more efficient he will be when he graduates.

I shall be glad to see this time element discussed.

Buffalo, N. Y. GEORGE HEALD.

What's the Matter with Our Methods of Threading?

There may be something wrong, but I am certain it is not wholly in the threading. I feel that our chief trouble lies in the gaging. We can go on producing as perfect a thread as is possible; but if we have to depend upon such gages as are being turned out at present by gage makers, we never will find a remedy.

The editorial in question happens along at an opportune time. The words "accuracy" and "precision" have been supplemented by "good enough" and "let is go at that." The Whitworth thread gages for the nose of 18-lb. high-explosive shells are a standing joke in our community. No two correspond. I considered it a joke due to ignorance when a tool maker (?) told the inspector he would make his gage small enough to fit the test gage; after swelling his chest and shining his "mikes," he elaborately ground off the top of the threads. But when I received a certified gage from a maker claiming to make accurate gages and found the top ground off to make the outside diameter right, my feelings were not fit to print.

It is admitted that a Whitworth thread gage is one requiring skill in its manufacture, but that does not excuse manufacturers for trying to palm off poor work on the anxious purchaser who pays the present high price for what is received. The way to be safe is to order a dozen thread gages and pick out an accurate one if you can find it, returning the others.

Some thread gages received from tool firms lately have threads so rough that a common wrought-iron pipe thread would blush if laid alongside of it. I am not naturally a pessimist, but I am affected with the same ailment as hundreds of others in the business and am hoping for a remedy.

JOHN HOMEWOOD.

Alberta, Canada.

Methods for Making High-Speed Steel Go Farther

SYNOPSIS—Details of four methods for attaching high-speed steel points to carbon-steel shanks in making single-pointed cutting tools. These methods include brazing with a brazing compound, brazing with a piece of sheet copper, welding with a flux composed of borax and mild-steel filings, and welding with the oxyacetylene flame.

The increase in the price of tungsten steel, its scarcity and the scarcity of tungsten metal bring into importance all the means of successfully using high-speed steel points or bits for machine-shop tools. Several methods of brazing or welding high-speed steel points to mild-steel shanks have been shown in the *American Machinist* during the past five years, and such processes are by no means unknown in American machine shops.

With the purpose, however, of aiding in the economical use of the present available supply of high-speed steel for single-pointed tools, four methods of attaching high-speed steel tool points to carbon-steel shanks are described in detail. Three of these are from the practice of British shops and one from an American shop. The source of the first three is a circular issued by the British Ministry of Munitions to British workshops, some copies of which have reached American shops. Commenting on the importance of conserving the supply of tungsten steel, the opening paragraph of this circular reads:

"Owing to the present scarcity of tungsten, it is of the highest national importance that every practicable economy should be exercised in the use of high-speed steel, and in order that this may be done, the use of high-speed steel points brazed to carbon-steel shanks is strongly recommended. Tools made in this way are very widely used and are undoubtedly successful, and are much cheaper than tools made of high-speed steel throughout, so that, even from the economical point of view, apart from considerations of national economy, the process is most desirable. In order to enable you to put the process into practical operation in your works, the following information is afforded."

These three British methods are, first, brazing, using a commercial brazing compound; second, fire welding, using a flux composed of a mixture of borax and mild-steel filings; and third, brazing, using a thin sheet of copper and powdered borax between the point and the shank. The fourth method, taken from an American shop, shows and describes in detail a process of preparing both point and shank for flame welding, using the oxyacetylene torch. This method is also used in British shops, and the circular lists the names of several that are in a position to demonstrate the particular processes used.

The method of preparing shank and point for the British methods is illustrated in Fig. 1, reproduced from the circular of the Ministry of Munitions previously referred to. The accompanying explanation reads:

"The illustration shows the appearance of a tool ready for the brazing process. The shanks are pieces cut off from rectangular black bar and can be made of ordinary mild steel, although in practice it is found that steel having 0.5 per cent. of carbon gives better results. The end of the shank which is to receive the high-speed steel point is ground down about ⅛ in. so as to present a clean surface for brazing and location for the high-speed steel point which is ground upon the two faces which are in contact with the shank. . . . ."

First British Method—Brazing With a Commercial Compound

"According to one method, the brazing is accomplished by means of a brazing compound which is known as Laffitte's brazing compound and which does away with the use of borax or any other flux. This compound is supplied in small compressed plates or sheets, and in practice a sheet of the compound is placed between the high-speed steel point and the shank, the whole being wired together as indicated by the illustration. The brazing is usually accomplished in a high-speed steel furnace, of the type which contains two chambers, one for preheating and the other for the final high temperature required for hardening the high-speed steel. In cases where this type of furnace does not exist, the preheating can be done in any furnace, the object of preheating being to enable the brazing compound to run effectively and to

FIG. 1. POINT WIRED TO SHANK FOR WELDING OR BRAZING

avoid cooling down the high-speed steel furnace by placing cold steel in it. The three parts, bound together as described, are placed in the first furnace and brought up to red heat, after which they are removed and the high-speed steel point is tapped lightly with a hammer to distribute the brazing compound between the two faces, after which the tool is put into the high-speed steel furnace and brought up to the proper heat for hardening. While this is being done, the tool should be carefully balanced so that the point does not slip away, as it is liable to float on the brazing compound, which is fluid.

"After removing from the high-speed steel furnace, a jet of air should be directed on the nose of the tool in the usual way, after which the tool can be dressed to shape on a grindstone."

This method is used by Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd.; Mather & Platt, Ltd.; Vickers, Ltd.; Ruston, Proctor & Co., Ltd.; Alfred Herbert, Ltd.

Second British Method—Fire Welding With Borax and Fine Steel Filings

"This method is in use by a number of engineering firms. The compound used as a flux is a mixture of borax and mild-steel filings, or cuttings obtained from a hacksaw.

"The borax is purchased in crystals, but before mixing with the steel filings is melted slowly until it becomes liquid and is then allowed to cool, when it is pounded down to a powder. The proportions are one part of borax to two parts of steel filings or cuttings.

"The shank of the tool is shaped at the point in the same way as for the first method, see Fig. 1, and the same applies to the high-speed steel point.

"Before putting on the point, the shank is put into the fire and heated for 2 in. up or more, according to the size of the tool, to a red heat. It is then cooled for ½ in. long at the point before putting on the flux.

"The flux is then put on about ⅛ in. thick, for a 1-in. square tool, and the high-speed steel point is laid on the top. The tool is then put into the fire and brought to a good red heat, after which it is taken out and examined to see whether the point is in correct position. If found to be so, it is given a few blows by the round of a hammer so as to fix it and to keep it from moving in the further process. It is again put into the fire and brought up to a welding heat, after which it is brought again to the anvil and welded, the blacksmith holding a fuller or rounding tool on to the high-speed steel point, and the striker using a small hammer striking blows quickly and lightly.

"The fuller is kept in the first instance toward the back end of the point, as, if used at the front, the tool would collapse owing to the soft nature of the shank. After the point has been fairly fixed at the back, it is gradually worked up toward the end, using very light blows, and, by this time has cooled down considerably and can bear the light hammering without giving way.

"The hardening is then performed as before described; and after hardening, it is well to strike the shank of the tool on the anvil so that the sudden jerk will cause the point to tumble off if it has not been properly welded."

This method is used by John Lang & Sons, Johnstone, Scotland.

"The mild-steel shank and high-speed steel point are prepared as shown in Fig. 1.

Third British Method—Brazing with Sheet Copper and Powdered Borax

"For brazing, a piece of sheet copper about $^1/_{25}$ in. [0.040 in.] is placed between the shank and the point and powdered with borax (prepared as in the second method) sprinkled thickly both underneath and on top of the copper. The tool is then carefully put into a smith's fire, the most important thing being to see that the tool is perfectly level so as to prevent the point from slipping off when the copper melts. Wiring the point on, as shown in Fig. 1, will assist in preventing this. The front of the tool is then raised to a dazzling white heat, the copper melts and adheres to both shank and point. The tool is then carefully withdrawn from the fire and cooled down in an air blast until it is at a black heat, when it can be put in water. For this process the shank is preferably milled; the milled part should be perfectly flat and the point ground to fit."

This method is used by Messrs. Siemens Bros. Dynamo Works, Ltd., Stafford, England.

Fourth Method—Welding with the Oxyacetylene Flame

The circular of the British Ministry of Munitions also mentions the fact that the oxyacetylene process of flame welding is successfully employed by several firms who are willing to demonstrate their processes to interested parties. The list of firms comprises: Messrs. Werner, Pfleiderer & Perkins, Ltd., Peterboro; James Bennie & Sons, Clyde Engine Works, Govan; Burmeister and Wain Oil Engine Co., Ltd., Glasgow; Fairbairn MacPherson, Wellington Foundry, Leeds; John McDowall & Sons, Walkinshaw Foundry, Johnstone; Willans & Robins, Ltd., Victoria Works, Rugby.

This flame-welding process is also used in the United States, and Fig. 2 and the following description are from the practice of the Root & Vandervoort Engineering Co., East Moline, Ill.

The mild-steel shank and high-speed steel point or bit are shaped as shown at *A* and *B*, Fig. 2. The details give the proportions of one kind of round-nose turning tool for roughing cuts, and for both right-hand and left-hand setting. The shanks and points may be forged or machined to the shapes given, but in the case of forgings the angular surfaces must be ground to free them from scale.

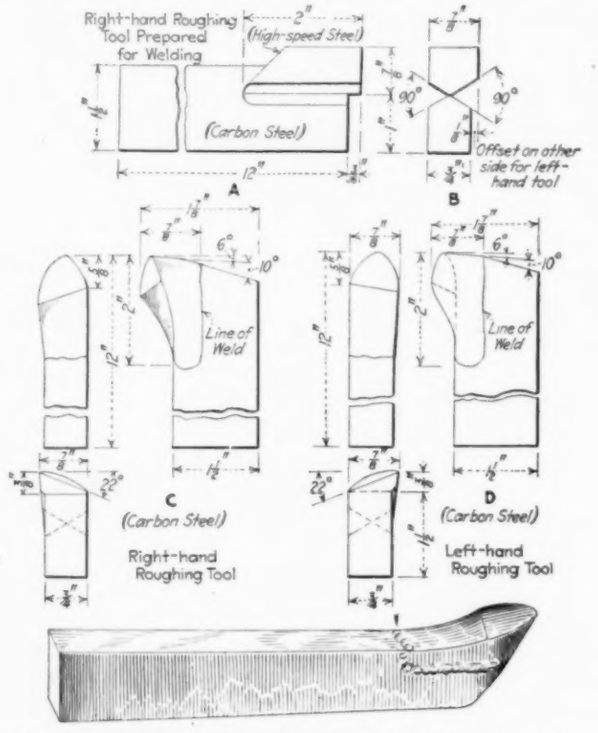


FIG. 2. DETAILS OF TOOL WITH OXYACETYLENE-WELDED POINT

When welding, the tool is laid on its side and the parts blocked up so that they are in proper relation to each other. They are then welded, using an oxygen-acetylene welding outfit, with a torch having a tit, giving a flame about ⅝ in. long. Round Norway iron $^3/_{16}$ in. in diameter is used for filling, and care is taken to prevent the flame from touching the high-speed steel point. The operator keeps the welding rod between the flame and the piece of high-speed steel. The angular grooves on the sides of the tool, as shown at *B*, are filled up a little more than flush, and most careful attention is given to see that a first-class weld is made.

After the tool is welded, no hammering of any kind is done on it, and all shaping is done by grinding. After rough grinding, the tool is hardened in the usual manner, and then after finish grinding, it is ready for use.

The finished shape and dimensions of a right-hand roughing tool made by this method are shown at *C*, and a similar lelft-hand tool at *D*. Fig. 2.

Editorials

The Need for a Uniform and Safe Boiler Code

Securing the safety of employees has become a very important function of shop management, but in too many cases it is confined to the shop and does not extend to the boiler room. This in too many small plants is so situated as to cause widespread damage in case of explosions. There are on the other hand many small shops which rent power and have no control over the power plant that may possibly blow up the whole shop.

The way toward safety lies in the direction of adopting stringent but rational laws concerning boilers, and all shop managers, whether supplying their own power or renting it, should be interested in the matter of safe boiler rooms.

A step in this direction is to secure the adoption of the Boiler Code of the American Society of Mechanical Engineers, which is the result of careful study and investigation by some of the best engineers of the country. That such action is necessary can be judged by the record of one insurance company last year, which shows that its inspectors found nearly 25,000 serious defects and had to condemn almost 800 boilers which they found in use.

Every safety engineer should be interested in the movement to secure safety in the boiler room as well as the shop, and particularly because it is a constant menace to the safety of such a large number of employees. The rules governing boilers on locomotives in interstate commerce, as well as the rules for marine service, show that the Government engineers have for years recognized the danger of boilers. And as they are so closely connected with manufacturing industries, it behooves us all to work for the adoption of adequate boiler codes by all the states. To this end the American Uniform Boiler Law Society has been formed to secure the legal adoption of the A. S. M. E. Boiler Code. This consists of twelve members, representing about all branches of the boiler-making industry, who are all devoting time and effort to secure its adoption. Everything seems to favor the movement, and the machine industry should aid so far as lies in its power.

Reclaiming and Handling Oils

Somewhere on the outskirts of every machine shop—often out-of-doors—is a greasy, evil-smelling place where steel chips are stored. If any quantity of these is allowed to accumulate, one will probably find pools of oil that have drained away and settled in near-by holes in the floor or depressions in the ground. That oil cost money. Along with the oil that drained from those chips has gone the loss of good dollars. These puddles of dirty, stinking oil are a text from which many a shop manager should preach a sermon on economy.

His "firstly" might be an attack on the inefficiency of the design and operation of the centrifugal chip and oil separating machines. On the design side, many of these are intended to be run at too slow a speed to bring about proper separation of the oil from the chips. Recent experiments seem to show that the smaller-sized machines are more efficient than the larger; that is, they turn out drier chips. On the operation side, the length of time that the chips are allowed to stay in the separator has a marked influence upon the degree of dryness. It is wise to make an occasional test to determine just how long it is economical to whirl the chips. Another handicap to the efficient operation of such centrifugal separators is the need of stopping the machine to empty and refill the pan. There seems to be no good reason why such machines should not be arranged to be filled and emptied while in motion.

"Secondly" in this sermon on shop economy the manager might well deal with the methods of transporting the chips from the screw and other machines to the centrifugal separator. The usual devices—a leaky wheelbarrow, sieve-like metal cans and slopping oil buckets—teach their own lessons. Oil-tight receptacles should be used throughout, and these should be loaded, filled and transported in such a fashion that there will be a minimum of dripping down the sides and slopping on the floor. If every gallon of oil should be thought of as a quarter of a dollar, it might emphasize the lesson.

The "thirdly" should emphasize the importance, after the oil has been reclaimed from the chips, of the cleaning and purifying processes to fit it to be returned to the machine tools. The really effective oil-filtering plant in a machine shop seems to be a species of rare bird. Yet the reasons that make careful filtration a necessity are many.

Oil that has been run through a metal-cutting machine is dirty; it is filled with fine metal particles, grit and iron oxide, or rust. The latter impurity comes from the action of the acid in the oil, which readily attacks the steel chips, particularly when they are hot. It may be pointed out that mineral oils are not supposed to contain free acid, but a great deal of screw-machine work is done today with an oil blended from mineral lard oil and hog lard oil. Hog lard oil always contains a certain percentage of fatty acid. The older the oil, the more it has been used, the more it has been exposed to the air, the greater this amount.

The result of proper cleaning by filtration is to supply a reclaimed cutting lubricant that does not dull and grind out the cutting tools, that has a minimum of free acid and helps to produce accurate, uniform work. It is recognized that impure or improper cutting lubricants have an influence upon the sizes cut by the tool, although this action has never been satisfactorily explained. The experiment has been tried of tooling up a screw machine and beginning cuts with lard oil. After the sizes were properly established all of the lard oil was pumped out and its place taken by another oil or cutting compound. There followed an actual difference in the sizes cut when the change in lubricant was made. To check the apparent results, the experiment was carried farther, and with

unchanged tool setting the machine was pumped out again and the original lard oil replaced. At once the normal sizes were cut by the tools. Thus all other conditions being the same, the condition of the lubricant affects the sizes of the work.

In addition to these items of economy the sermonizing general manager as his "fourthly" and "lastly" should insist upon the sterilization of the cutting oil each time it is filtered. It is well known that blood poisoning often follows the entrance of impure oil into scratches and minor hurts.

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Influence of Electric Motors on Machine Tools

"Better knowledge of the data governing the design of machine tools.

"Greater possibilities in regard to power.

"Closer control of a machine tool in regard to speed, stopping, starting, etc.

"Flexibility of the use of machine tools, by making them portable, and by making a better shop construction possible."

In these four items A. L. De Leeuw sums up the beneficial influence of the electric motor on machine tools, in a paper presented at the International Engineering Congress, held in San Francisco. The changes that have come because of these influences are often difficult to trace, because high-speed steels were introduced, practically speaking, simultaneously with the application of the electric motor. The effect of each has been pretty much the same.

From the first the electric motor provided means for ascertaining the amount of power required to drive machine tools. With a better understanding of what these power requirements were, came a knowledge of the strains and stresses developed in machine-tool members. It is probably true that all of the existing knowledge in regard to the power and pressures exerted in machine-tool operation is due to the adoption of the electric motor as a driving means. And what is true of our knowledge of power and pressures is also true of our information in regard to speeds. With an increase in our appreciation of the stresses of machine-tool members have come improvements in frame construction, particularly in designs to insure rigidity. With an increased knowledge of what speed means in production has come a deliberate attempt to gain greater convenience in machine-tool handling. And with the adoption of chains and gears, which could not be run in the open because the device must be properly lubricated, has come an increase in the safety of machine-tool mechanism.

All of these changes sum up under the first influence listed by Mr. De Leeuw. In fact he believes this to be the greatest of the four, and says:

"The writer believes that the most marked and most beneficial influence of the electric motor on machine tools has been the bringing into view of the lack of the fundamental knowledge of machine tools, and that it has opened up a new era for the machine tool, which may be called the scientific era."

In contrast to the scientific era that we are just entering, he pictures the past as follows:

"Machine tools have been the product of the requirements of mechanics. They were simply contrivances to help the mechanic in his work. They were more or less highly developed implements. Their various features were products of development and evolution, rather than of invention. The scant knowledge of their principles was the result of observation, rather than of experimentation. Mathematics had never been applied to machine tools. The stresses and strains to which machine-tool members were subject were not known. The forces required in the machine tools and the amount of power for certain work to be done in a machine tool were absolutely unknown, and what is more, this lack of knowledge was not recognized as such. It is due to the electric motor that this condition of affairs in regard to machine tools has become recognized, and that efforts have been made to put their design and application on a more scientific basis. It must also be stated here that very little has been done, so far, along this line. Nevertheless, we must thank the electric motor for the fact that we are now aware of our ignorance and are at last put in a position to seek for knowledge and data, on which a theory of machine tools may ultimately be built."

The influence in regard to the application of power in machine tools is perhaps as apparent as any. With the opportunity to apply more power, more was used, until now motors are connected to ordinary-sized machines of a rating that was unthought of a few years ago. To be sure, the requirements of high-speed steel go hand in hand with the ability to apply more power. And when we observe the final effect we must not forget that both factors have contributed to the increase.

The closer control of machine tools has become a reality and has led to such expressions as "centralized control," "localized control" and others. These are now almost everyday expressions in describing the features of machine tools.

The item of flexibility needs no amplification. It is customary so to drive all machines in isolated locations—those set up under craneways, those intended for special overtime work, those that are portable and those intended to be used on floor-plates. Flexible shafts and other connections of the days before are now almost forgotten.

To turn the tables, it must be remembered that machine tools have also influenced the design and application of motors. The requirements of machine-tool operations have brought into being the adjustable-speed motor in its various forms. The same requirements have brought in the reversing motors for planers and a number of systems of machine-tool motor control. In spite of this it is probably true that the fundamental design of motors has not been materially affected.

One of the most desired things at the present moment is a standardization of machine-tool motor proportions and sizes in such a fashion that we may have the much desired elements of interchangeability and uniformity. With the influence and inter-reaction of the electric-motor industry and the machine-tool building industry, such standardization ought to be possible at a not far distant date. It would be a further influence of machine-tool design upon electric-motor design.

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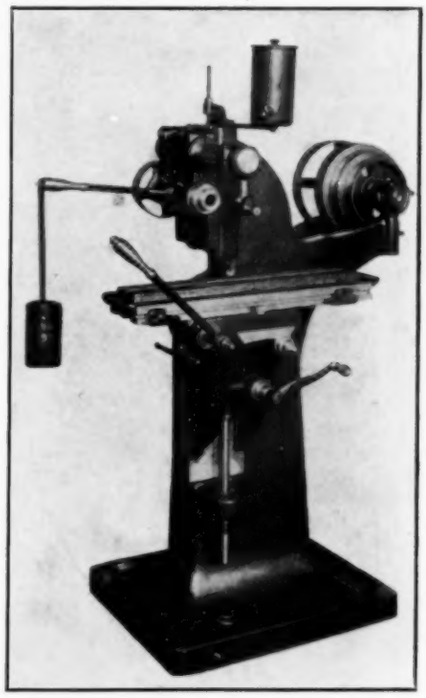
On page 110 is reprinted editorial comment from the *Engineering and Mining Journal,* pointing out that relief from the present scarcity of tool steel may be found in the substitution of molybdenum for tungsten as the principal alloying element.

Shop Equipment News

Hand Miller with Weight Feed

The illustration shows a hand miller recently developed by the U. S. Machine Tool Co., Cincinnati, Ohio.



HAND MILLER WITH WEIGHT FEED

In general the design and construction will be apparent from the illustration. It will be observed that a weight feed is provided for use on both the cross and the vertical feed.

Milling Multiple Keyseats

The tool shown is an adaptation of the regular type of keyseat-miller tool made by the National Machine Tool Co., Cincinnati, Ohio. The difference between this and the regular type is the addition of a demountable guide which is used in conjunction with the regular guide to obtain the correct spacing of the multiple keyways, or splines. While these tools are made specially to mill double, triple or quadruple keyseats, the one shown was made to mill the keyways in a six-spline automobile gear, shown at the right. In this case the additional guide is spaced one-sixth around the circumference of the body from the regular guide.

When using this tool, the first keyway is milled without the use of the additional guide. Then the additional guide is screwed into its locating slot and inserted into the milled keyway. As the end of this guide extends down below the cutter, it enters the cut keyway far enough ahead of the cutter accurately to space and steady it for the second cut. When this is milled, the tool is again set with the spacing guide in the keyway last milled, and so on around the hole. These tools can be used in any good-sized drilling machine.

Torpedo-Flask Boring Machine

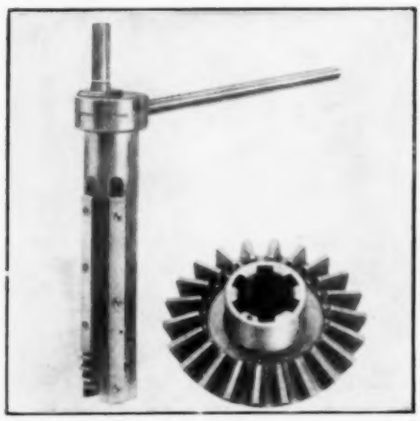
The illustration shows a machine recently developed by the Newton Machine Tool Works, Inc., Philadelphia, Penn., for rapidly finish-boring torpedo flasks.

The outside of the flask is gripped in two revolving chucks which are rotated in unison by a common shaft through wormwheels. The boring bar is stationary and is equipped on each side with tool heads which pass each other without interference.

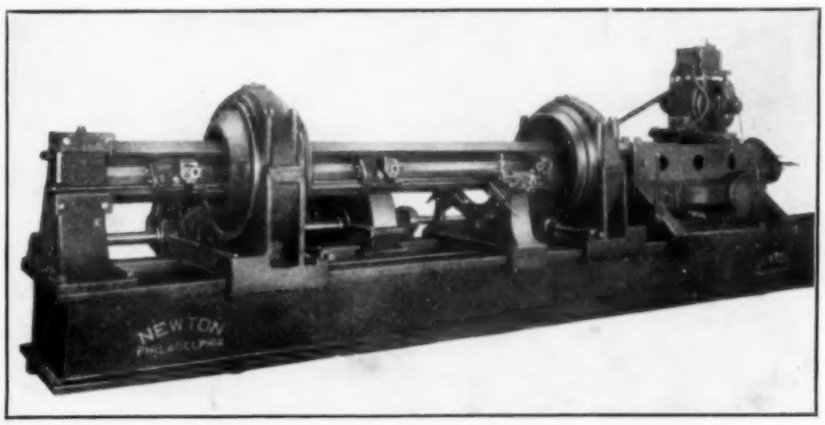
Each tool head has power feed along the bar, with automatic release, and has adjustment at right angles to the axis of the bar in a movement controlled with formers conforming to the contour of the flask.

The main head, on which the drive motor is mounted and to which the boring bar is attached, has reversing fast-power traverse on the base to permit the insertion and withdrawal of the boring bar after the flasks are located in the revolving chucks.

When inserting the flasks, the idea is to adjust one head away from the stationary or end head, to give a



MULTIPLE KEYSEAT TOOL

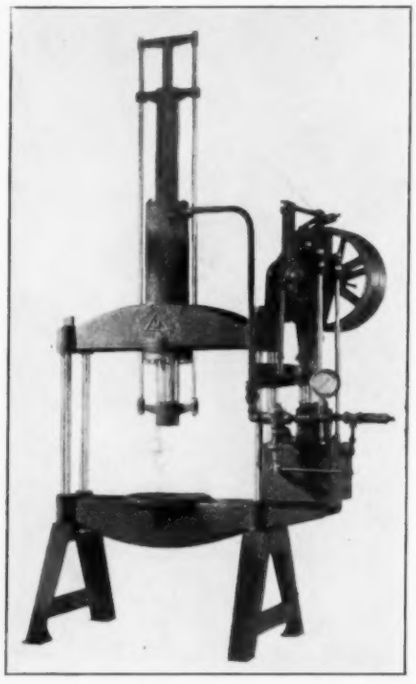


TORPEDO FLASK BORING MACHINE

distance greater than the length of the flask, which is then moved horizontally through the chuck on the stationary head; the movable head is adjusted back over the flask until it reaches the desired position. The chuck jaws are of special design.

Vertical Hydraulic Press

There is little explanation needed as to the construction or scope of the press shown. The design of the machine is such as to make it adaptable to a wide variety



VERTICAL HYDRAULIC PRESS

Stroke, 18 in.; distance between columns, 42 in.; distance from platen to ram, 24 in.; capacity, 20 tons

of straightening, forcing and broaching work. The ram pullback is by air or counterweight.

The constructional details in general follow the lines of the previous machines made by the builders—the Metalwood Manufacturing Co., Detroit, Mich.

Heavy Cone-Driven Lathe

The Bridgeford Machine Tool Works, Rochester, N. Y., has strengthened and otherwise improved the 26-in. lathe, as illustrated herewith.

The improvements include a further reinforcement of the bed by using a center rib, and the addition of a rack and pawl at the rear of the tailstock for use on heavy work. Both headstock and tailstock have been improved as to strength, rigidity and lubrication. The lathe is now built with either a 3-step cone for 5-in. belt or with 4 steps for a 4-in. belt, as may be desired. The apron is of the double-wall type. Spindle speeds of 6 to 260 r.p.m. are available. The machine weighs 8,000 lb. The spindle, which has a 2⅛-in. hole through it, has bearings of bronze; the driving gears are cut from the solid, having coarse pitch and wide face for heavy duty. The back gear sleeve and pinion are a steel forging.

The carriage is of heavy construction and has a 38½-in. bearing on the V's. There are independent frictions for both cross and lateral feeds, these being controlled from the apron. This provides the usual interlocking mechanisms to prevent the engagement of both feeds at once. The apron is of the double-wall type and this, together with the compound rest and cross slide, is of extra heavy construction.

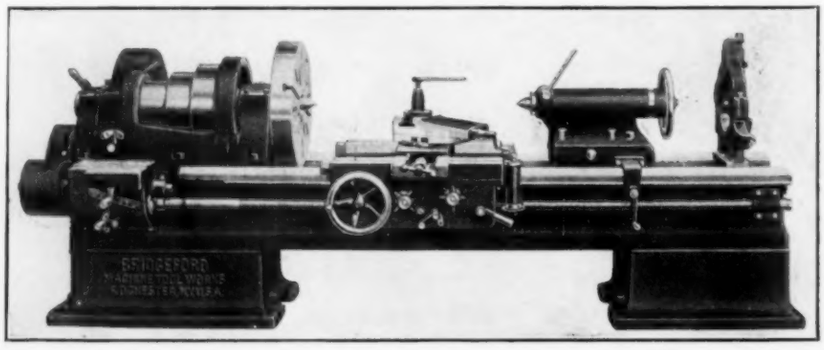
The regular equipment includes large and small faceplates, compound and center rests, the standard set of change gears, countershaft of self-oiling type and either American or English tool post.

"Clipper" Belt Lacer

In the illustration is shown a new model of the Clipper belt lacer, known as the No. 3. It is designed to lace belts more easily, from the added strength and the power which can be applied. This increased power is estimated

CLIPPER BELT LACER

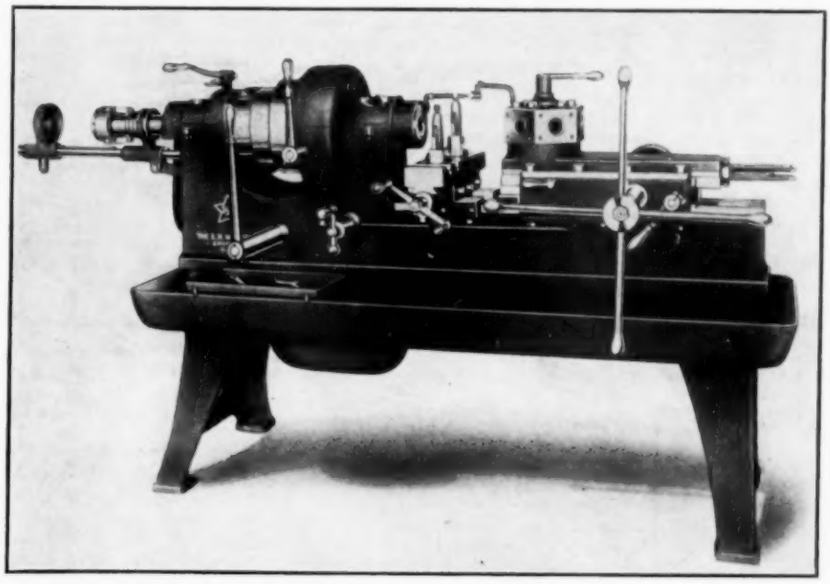
at 50 per cent., enabling an average man to push 6 in. of hooks into a belt. The lacer shown is the latest model of the Clipper Belt Lacer Co., Grand Rapids, Mich.



HEAVY-DUTY 26-IN. MANUFACTURING LATHE

Hand Screw Machine

The hand screw machine shown is a 1¼-in. machine, having a friction geared head, positive power feed to the turret slide, independent stops, automatic chucks, wire feed, oil pump and piping. All operating levers



FRICTION-HEAD HAND SCREW MACHINE
Collet opening, 1½ in.; power feed, 9 in.; 6 turret holes

are within easy reach, with reverse obtained through countershaft.

The maker, the E. H. Wachs Co., Chicago, Ill. is not a newcomer, but is merely reëntering a field of former endeavor, with a lathe of new design.

Present Government Attitude Toward Business

Since the enactment by Congress of the Federal trade-commission law and the Clayton law, the Federal Trade Committee of the Chamber of Commerce of the United States has been constantly presented with inquiries not only relative to the relationship which it might be expected would be established between the Department of Justice and the Federal Trade Commission at points where jurisdiction seems to overlap, but also as to the probable attitude of the Department of Justice with respect to future proceedings.

It was explained to the Attorney General by the representatives of the national chamber that if he would express himself it might be regarded as reassuring to the public mind and at the same time dispel some of the uncertainty which has heretofore existed. Several interviews have resulted between the Attorney General and members of the Federal Trade Committee, and the latter body now offers the following summary:

"Persons entering into transactions in good faith, having good cause to believe them lawful, will not be criminally prosecuted, but if their business be found violative of the law, they will be given opportunity to readjust in conformity with the law without legal proceedings, unless consent decree in a civil suit is desired.

"The Department of Justice intends to give substantial recognition to the provisions of paragraph E of section 6 of the Federal trade commission law, which authorizes the commission 'upon the application of the Attorney General to investigate and to make recommendations for the readjustment of the business of any corporation alleged to be violating the anti-trust acts in order that the corporation may thereafter maintain its organization, management and conduct of business in accordance with law.'

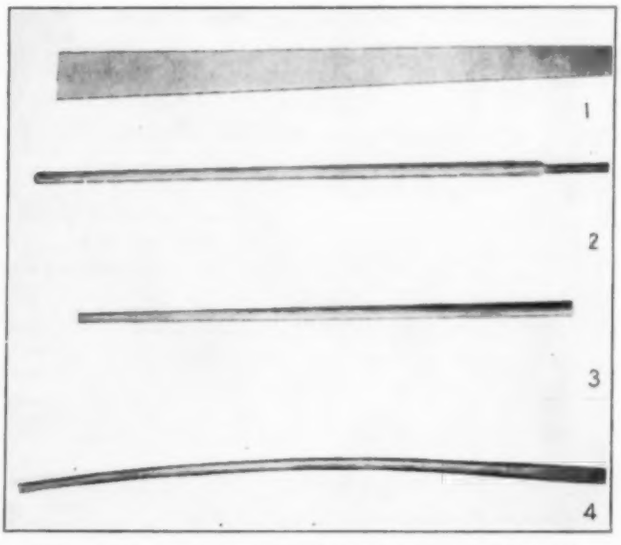
"In cases as to which both the Department of Justice and the Federal Trade Commission have jurisdiction, such for example as those arising under the Clayton act, the department will await the conclusion of the commission's proceedings as to any matters in which the commission's jurisdiction is first invoked.

"It is not improbable that the working arrangement between the Department of Justice and the Federal Trade Commission is to follow along the same lines as have been established by custom as between the department and the Interstate Commerce Commission with relation to violations of the act to regulate commerce, as a result of which arrangement the department rarely, if ever, institutes proceedings without the recommendation or sanction of the Interstate Commerce Commission."

This explanation of the official attitude toward the trade laws involved will no doubt clarify the situation.

Making Sword Scabbards

The making of scabbards has been done in the past by a number of concerns, usually in small quantities, as the demand is limited in the United States. Since the



FIGS. 1 TO 4. THE CUTTING AND FIRST ROLLING OPERATIONS ON THE SCABBARD

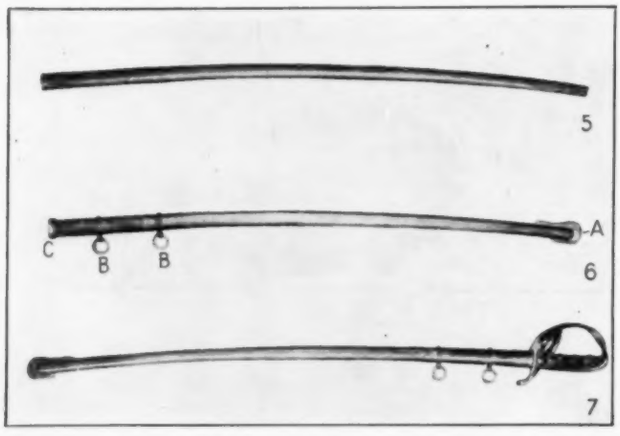
beginning of the European War, however, other firms have become interested in their manufacture. With this fact in mind and thinking that the description will prove of interest to the reader, the operations followed in making scabbards are here set forth.

The firm of Charles Schilling, Philadelphia, Penn., is one of the oldest in the industry, having been in existence with the present owner and his father for over half a century, and the illustrations and methods here outlined were obtained at this shop.

The first operation in making the scabbard is cutting to shape. For this work a templet is laid on the steel sheet and the shape marked off. This shape is then cut out with power shears. The steel used for making scabbards is No. 21 gage (0.034 in.) thick. One of the scabbard blanks is shown in Fig. 1.

Rolling the Blank Straight

The blank is bent over by hand and the steel former, Fig. 2, placed on the inside. The former and the blank are then gripped between jaws in a machine, and a hardened-steel roller made with a concave face is fed over. This action forces down the blank against the former. The roller is fed down and made to travel across the blank until it has been forced to the shape of the former. The



FIGS. 5 TO 7. THE FINAL OPERATIONS

scabbard is then slid off and the longitudinal seam brazed, a coke fire being used to obtain the necessary heat.

The scabbard, after it has been rolled straight and brazed on the seam, is shown in Fig. 3. The part is slightly bent over in a vise until it can be slid on the curved former, Fig. 4.

It is then placed in a set of vise jaws, which are made with a contour similar to the former, and dropped into position in the same machine used for the straight rolling operation. The roller is operated in a like manner until the scabbard has been forced to the same shape as the former. The part is then removed and the lower end peened over and brazed. One of the scabbards at the conclusion of these operations is shown in Fig. 5.

Final Operations on the Scabbard

The scabbard is ground all over on the outer surface until the desired smoothness is obtained. The shoe *A*, Fig. 6, strap rings *B* and top guard *C* are then slot soldered into position, as shown. The scabbard is finally nickel-plated and polished until the proper finish is secured.

One of the scabbards with a sword in position, ready for delivery, is shown in Fig. 7, and the finish produced and final appearance of the scabbard are apparent.

NEW PUBLICATIONS

HOW TO RUN AND INSTALL GASOLINE ENGINES. By C. von Culin. 96 pages; 3⅝x6 in.; paper covered. Published by the Norman W. Henley Publishing Co., New York. Price, 25c.

This is a handy little pocketbook for those installing or using gasoline motors. It is written particularly for users of motor launches, and in addition to information concerning the motor itself, it deals with navigation and hull construction of small boats.

FORD ENGINE CHART. By Victor W. Page. 25x38 in. Published by the Norman W. Henley Publishing Co., New York. Price, 25c.

This chart shows sectional and assembled views of the Ford engine and transmission units, the thermo-siphon cooling system, the Ford ignition system and the carburetion group, from the gasoline tank to the motor manifold. It names all the different parts and shows their relation to one another. In addition it gives considerable condensed information as to the various troubles which can occur in an internal-combustion motor, the symptoms shown by the different troubles and, by inference, the proper remedy. It should be useful to both the user and repairman.

PRACTICAL APPLIED MATHEMATICS—By Joseph W. L. Hale. Two hundred and six pages, 4½x7 in.; 185 illustra- Published by the Norman W. Henley Publishing Co., New York.

Reviewed by Dexter S. Kimball*

This book and its companion volume, entitled "Practical Mechanics," by the same author, are intended for use in trade apprentice schools, the two taken together constituting a fairly comprehensive, though simple, presentation of elementary mathematics and mechanics. An effort has been made therefore to obtain a logical sequence throughout the two volumes. These books are based on instruction sheets developed by the author in five years' experience organizing apprenticeship schools for the Pennsylvania R.R.

The contents of this volume are presented in 20 short chapters under the following headings:

Simple Processes (in arithmetic), Common Fractions, Decimals, Percentage, Ratio and Proportion, Measurements of Angles (elementary geometry), Mensuration of Rectangles and other Four-Side Figures, Mensuration of Triangles, The Circle (its properties and its mensuration), Mensuration of Simple Solids, Use of Rules and Formulas, Simple Equations, The Binomial, Use of Tables and Curves, Cube Root, Mensuration of Prisms, Pyramids and Cones, Mensuration of Miscellaneous Solids, Miscellaneous Rules for Polygons, Miscellaneous Rules for Length, Area and Volume, Metric System, and an Appendix containing tables of square roots, cube roots, etc.

The volume is therefore an elementary treatise on arithmetic with comprehensive applications. As might be expected, many of the illustrations and problems are drawn from the field of railway practice; in fact that is so much so, that the book may not be so interesting to students in other lines of work as its scope and purpose warrant. While the treatment is simple and concise, the contents of the book are by no means watery, and the student who has mastered it will have a sound mathematical basis for the trades. It would probably prove a little difficult for independent study, but it should be found useful in technical high schools and in trade and vocational schools generally.

PRACTICAL MECHANICS AND ALLIED SUBJECTS—By Joseph W. L. Hale. Two hundred and twenty-eight pages, 4½x7 in.; 201 illustrations; indexed. Price, $1. McGraw-Hill Book Co., New York.

Reviewed by Dexter S. Kimball*

This book and its companion volume, entitled "Practical Applied Mathematics," by the same author, are intended for use in trade apprenticeship schools, the two taken together constituting a fairly comprehensive, though simple, presentation of elementary mathematics and mechanics. An effort has been made, therefore, to obtain a logical sequence throughout the two volumes, and hence this volume presupposes a knowledge of elementary arithmetic and simple arithmetical applications. Both books are based on instruction sheets developed by the author in five years' experience in organizing and operating apprenticeship schools for the Pennsylvania R.R.

*Professor of machine design and construction, Sibley College, Cornell University.

The contents of the book are presented in 20 short chapters under the following chapter headings:

Forces (general conceptions), Gravitation, Density and Specific Gravity, Screw Threads, Calculation of Levers, Pulleys (Block and Tackle), Inclined Plane and Wedge, Gears and Lathe Gearing, Belts and Pulleys (considered as mechanism only), Efficiency of Machines, Motion, Cutting Speeds, Volume and Pressure of Gases, Work and Power, Calculation of Belting (for power), Energy, Heat, Logarithms (with simple applications), Measurement of Right Triangles (elements of trigonometry), Measurement of Oblique Triangles (further trigonometry), Electricity, Strength of Materials.

Unlike its companion volume, the illustrations and problems included in this book are not drawn to any considerable extent from the railway field but are quite general in their scope. The treatment is concise and practical and the book contains a large amount of information for its size. Like its companion, it will probably be rather difficult for independent study, but when a student has mastered it he will have accomplished something worth while.

There are a few consistencies in its make-up however. One wonders why in a book of this character, where space is so valuable, three pages should be devoted to a drawing of a lathe and a tabulation of its 300 parts, or why another page should be devoted to pictures showing ten tools used by machinists, or why it is more important to there illustrate the hacksaw than a monkey wrench. But these, after all, are small defects in a book that has many valuable features.

PURCHASING—By H. B. Twyford. Two hundred and thirty-six 6x9-in. pages; 112 illustrations; indexed. Price, $3. D. Van Nostrand Co., New York.

The appearance of books on purchasing is another indication of the growth of the science of management. A few years ago purchasing ability was synonymous with personal shrewdness; and while, no doubt, some elements of this character will always remain it appears that even in this work there are basic principles that can be written into books.

This volume is a businesslike treatment of the problems and methods of purchasing as they appear to one who has had a long and varied experience in this field. It contains little on the psychology of buying, and such philosophy as it does contain is not of the speculative kind, but practical and direct.

The subject matter is presented under four main subdivisions and 15 chapters as follows: (a) Purchasing—(1) Principles of Purchasing, General Considerations; (2) Functional Position of Purchasing Considered; (3) Ethics of Buying. (b) The Purchasing Organization—(4) The Purchasing Agent; (5) The Purchasing Department; (6) Organization of Department; (7) System of Procedure. (c) Operation of Purchasing Department—(8) Obtaining and Tabulating Proper Records; (9) Work Connected with Requisition and Order; (10) Invoices and Method of Handling; (11) Operation of Stores. (d) Purchasing as Practiced—(12) Purchasing for Railroad Construction Work and for Operation of Electric Railroads; (13) Purchasing for a Manufacturing and Construction Co.; (14) Purchasing for Construction and Operation in Widely Separated Localities; (15) Purchasing for a Small Manufacturing Establishment.

The first section deals with the principles and ethics that underlie successful purchasing. The reasoning is sound, and the ethical standards are high.

The second section treats of the work of the purchasing agent, the relations that he and his department should hold to other departments and the general organization of the purchasing department. These chapters constitute a clear and intelligent solution of these problems; and while the plan is developed for a large organization, the principles laid down apply equally well to a small business. Mr. Twyford's idea that a purchasing department should intelligently serve the other departments instead of handicapping them, as is often the case, is worthy of attention.

The third section treats of the actual operations of a large purchasing department. Typical forms and blanks are inserted in sufficient number only to illustrate the important points.

Each chapter in the fourth section describes in some detail the purchasing department of some enterprise with which the author has had actual experience. The businesses referred to range from large and complex ones to a small and simple one. Each chapter is well illustrated with forms and blanks, the general idea being to present a range of practical illustrations.

The work is well written, the reasoning is clear, and the book on the whole is excellent. It should be helpful, not only to purchasing agents, but also to managers who have not given this important feature of management much attention.

One of the best features of the book is the care the author has taken to point out the limitations that should be observed in laying out systems of any kind and the danger from borrowing methods instead of developing such office machinery as the particular case demands. In other words, the book deals largely with principles and is not a mere collection of forms taken from the author's experience.

The reviewer takes exception to the author's inference in Chapter 11, that the method of drawing material from the stores by foremen's requisitions is better than the method by production orders made out in advance. If the saving of material costs is as important as the author says it is elsewhere in the text, no foreman should write requisitions, since this is one of the most wasteful of methods. A foreman who is doing his full duty has no time to do such work as accurately as it should be done, and as accurately as good cost-finding methods demand. Modern methods tend toward planning all operations in advance, the procedure including also purchasing of the material and the drawing of it from the storeroom in just the right quantities. Any progressive shop large enough to have a purchasing department anything like what Mr. Twyford advocates will also have some form of production department that will not only give the purchasing department accurate information regarding the material required, but will also advise the storekeeper just how much material a job requires and when it will be wanted.

PERSONALS

D. E. Jones has been promoted to foreman in charge of the night force at the factory of the Peters Cartridge Co., Kings Mills, Ohio.

Charles Piez, president of the Link-Belt Co., has been elected president of the recently organized Electric Steel Co., Chicago, Ill.

H. W. Kruesberg, president of the Champion Tool Works Co., Cincinnati, Ohio, was presented with a loving cup by his employees as a New Year's testimonial.

E. C. Waldvogel, for the past 11 years associated with the Yale & Towne Manufacturing Co., has been appointed general manager, with headquarters at the home office.

William H. Carpenter has been appointed manager of the Mayo Radiator Co., New Haven, Conn. Mr. Carpenter was formerly superintendent of the Bristol Brass Co., Bristol, Conn.

S. Shirley French, recently appointed assistant general manager of the William Tod Co., Youngstown, Ohio, has assumed the general management of the plant operations, succeeding L. A. Woodward, who has retired.

A. S. Baldwin has resigned as works manager of the R. D. Nuttall Co., Pittsburgh, Penn., to become manager of ordnance for the Poole Engineering and Machine Co., Baltimore, Md. Mr. Baldwin was previously held similar positions with the Driggs-Seabury Ordnance Corp. and the American British Mfg. Co., and was for four years general manager of the Alberger Pump and Condenser Co.

OBITUARY

George R. Ray, founder and president of the Manistee Iron Works, Manistee, Mich., died at his home in that city on Jan. 3.

George H. Cushing, plant superintendent of the H. B. Smith Co., Westfield, Mass., died on Jan. 6. Mr. Cushing was a native of Worcester, Mass., and was 55 years old.

William A. Comstock, president of the Cleveland Wire Spring Co., Cleveland, Ohio, died on Jan. 9 as the result of injuries sustained when he was struck by an automobile.

BUSINESS ITEM

The organization of the Electric Steel Co., of Chicago, Ill., represents a new development for that section in that the plant will confine itself to small castings of the alloy variety. The plant will be located at 31st and Wood St., in the former works of the Wildman Boiler Co., and the organization has progressed sufficiently to insure delivery of product by Mar. 1. The officers of the new company are: Charles Piez, president, and P. L. Coonley, secretary and treasurer, who are respectively president and vice-president of the Link-Belt Co. The active management of the company will be in the hands of John M. Olmsted as vice-president, who has been a member of the sales force of the Link-Belt Co. These three with W. C. Frye and C. R. Messinger, of Milwaukee, constitute the board of directors.

Prices--Materials and Supplies

PIG IRON—Quotations were current as follows at the points and dates indicated:

	Jan. 14 1916	Dec. 17 1915	Jan. 15 1915
No. 2 Southern Foundry, Birmingham	$15.00	$14.00	$9.50
No. 2 X Northern Foundry, New York	19.75	19.00	14.25
No. 2 Northern Foundry, Chicago	18.50	18.00	13.00
Bessemer, Pittsburgh	21.45	19.45	14.70
Basic Pittsburgh	18.70	18.45	13.45
No. 2X, Philadelphia	20.00	19.50	14.25
No. 2, Valley furnace	18.50	18.00	13.00
No. 2 Southern, Cincinnati	17.90	16.90	12.40
Basic Eastern Penn	19.50	18.00	13.50
Gray forge, Pittsburgh	18.45	17.95	13.45

MISCELLANEOUS METALS—NEW YORK

	Jan. 14, 1916	Dec. 17, 1915	Jan. 15, 1914
	Cents per pound		
Copper, electrolytic (carload lots)	24.00	20.00	13.75
Tin	41.00	40.00	33.50
Lead	5.90	5.40	3.90
Spelter	17.62½	18.00	6.05
Copper sheets, base	30.00	25.00	18.50
Copper wire (carload lots)	30.09	28.25	14.25
Brass rods, base	35.00	27.25	13.00
Brass pipe, base	38.00	32.00	16.50
Brass sheets	35.00	27.25	13.25
Solder ½ and ¼ (case lots)	25.75	24.25	22.00

ST. LOUIS

Lead ..... 5.77½ Spelter 18.50

In New York, Lake copper is quoted nominal at 24c. cash and deliveries are not promised until June.

MONEL METAL—The following prices hold:

Size, In.	Mill Lengths 8 Ft. and Over: 10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less than 500 Lb. of a Size and Over
Rounds—Squares	Cents per Pound				
1/8 — 1/4	31.50	32.00	32.50	33.00	36.00
5/16 — 1/2	31.25	31.75	32.25	32.75	35.75
9/16 to 1 1/4	31.00	31.50	32.00	32.50	35.50
1 5/16 to 2 1/2	31.75	32.25	32.75	33.25	36.25
Rounds 3 to 3 7/16	32.50	33.00	33.50	36.00	37.00
Squares 3	32.50	33.00	33.50	36.00	37.00
Rounds 3 1/2 to 3 15/16	32.25	32.75	33.25	35.75	36.75
Squares 3 7/16 to 3 15/16	32.25	32.75	33.25	35.75	36.75
Rounds—Squares 4 to 4 1/2	33.00	33.50	36.00	36.50	37.50
5 to 6 1/2	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ½ in. thick.
Hexagon Bars two cents (2c) per pound over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

STANDARD PIPE—

	Discount: Black Jan. 14, 1916	Black Jan. 15, 1915	Galvanized Jan. 14, 1916	Galvanized Jan. 15, 1915
¾- to 2-in. steel butt welded	77%	81%	62½%	72½%
2½- to 6-in. steel lap welded	76%	80%	61½%	72½%

At the above discounts, the net prices follow:

Diameter, In.	Cents: Black Jan. 14, 1916	Black Jan. 15, 1915	Galvanized Jan. 14, 1916	Galvanized Jan. 15, 1915
¾	2.65	2.20	4.31	3.15
1	3.91	3.24	6.37	4.67
1¼	5.29	4.38	8.62	6.30
1½	6.33	5.25	10.31	7.55
2	8.51	7.05	13.88	10.15
2½	14.04	11.70	22.52	16.70
3	18.36	15.25	29.45	21.80
4	26.16	21.80	41.97	31.00
5	35.52	29.60	56.88	42.20
6	46.08	38.40	73.92	54.60

SAL SODA—The quotations below are per 100 lb. at the places designated:

New York	$1.00
Philadelphia	.75

ANTIMONY—For spot delivery on Chinese and Japanese brands, duty paid 43c. per lb. is asked.

STEEL SHEETS—

Black	Cents per Pound: Sheets from Warehouse, New York Jan. 14, 1916	Dec. 17, 1915	Jan. 15, 1915
No. 12	3.00	2.70	2.20
No. 14	3.05	2.80	2.25
No. 16	3.15	2.90	2.35
Nos. 18 and 20	3.15	2.95	2.40
Nos. 22 and 24	3.20	3.00	2.45
No. 26	3.25	3.05	2.50
No. 28	3.35	3.15	2.60
Galvanized			
No. 24	5.05	4.80	3.05
No. 26	5.20	4.95	3.20
No. 28	5.50	5.25	3.50

ZINC SHEETS—The following prices prevail:

Quantity	Cents per Lb.
Carload lots, f.o.b. mill	23.00
In casks, New York	24.00
Broken lots, New York	25.00

SEAMLESS DRAWN TUBING—As we go to press, the base price is 35c. for brass and 35c. for copper. For immediate stock shipment 3c. is added, which gives the following quotations:

Diameter, In.	Cents per Pound: Copper Jan. 15, 1916	Copper Jan. 15, 1915	Brass Jan. 15, 1916	Brass Jan. 15, 1915
¾ to 2½	38.00	20.00	38.00	16.00
3	38.00	21.00	38.00	17.00
3½	39.00	21.50	39.50	17.50
4	40.00	22.00	40.50	18.00
4½	42.00	23.00	42.50	19.00
5	44.00	24.00	44.50	20.00
6	45.00	27.00	45.50	23.00
7	47.00	29.00	47.50	25.00
8	49.10	31.00	49.60	27.00

OLD METALS—The following are the dealers' purchasing prices in New York:

Copper	Cents per Pound: Jan. 15, 1916	Dec. 17, 1915
Heavy and crucible	18.50	16.50
Heavy and wire	18.00	16.00
Light and bottoms	16.00	14.00
Lead		
Heavy	12.50	4.25
Light	10.00	4.00
Brass		
Heavy	12.50	11.25
Light	10.00	9.00
No. 1 yellow rod turnings	12.50	11.50
No. 1 red turnings	12.00	11.00
Zinc	12.00	10.00

COKE—Below are the prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Dec. 25 1915	Jan. 1 1916	Jan. 8 1916	Jan. 15 1916
Prompt furnace	$3.00@3.50	$3.00@3.50	$3.25@3.50	$2.50
Prompt foundry	3.50@4.00	3.50@4.00	3.50	3.75@4.00

STEEL SHAPES FROM JOBBERS' WAREHOUSE, NEW YORK

	Jan. 14, 1916	Dec. 17, 1915	Jan. 15, 1915
	Cents per pound		
Steel angles base	2.50	2.40	1.85
Steel T's base	2.55	2.45	1.90
Machinery steel (bessemer)	2.50	2.40	1.80

The above prices are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger.

TURNBUCKLES—On sizes smaller than 1¼ in. diameter, 50% off list is charged, and on 1¼ up to 2 in. diameter 40%. At this rate prices follow:

Size	In.	Size	In.	Size	In.
⅜	$0.20	⅞	$0.375	1½	$0.90
½	.21	1	.44	1⅝	1.05
½	.225	1⅛	.50	1¾	1.20
⅝	.25	1¼	.75	1⅞	1.35
¾	.315	1⅜	.828	2	1.59

The above prices are for buckles having right and left stub ends and with openings between the heads measuring 5½ in.

ROLL SULPHUR in 360-lb. bbl, sells in New York at $2.15 per 100 lb.

COTTON WASTE—In New York, the prices below hold:

	Cents per Pound
White	8.50@9.50
Colored mixed	6.50@8.00

COPPER RIVETS sell at 35 and 5% off list and burs at 78½%.

Millholland Turret Lathe

SYNOPSIS—This machine is, as a whole, no radical departure from established lines, yet it embodies many original features developed during the experience of its designers. With these features are combined well-known devices. Safety, convenience and durability have apparently been the ideas kept uppermost in mind during its construction.

There are numerous features incorporated in a new machine, shown in Fig. 1, that will at once appeal to the practical user. This machine is the latest product of the W. K. Millholland Machine Co., Indianapolis, Ind., and is the combined result of two generations of engineering and mechanical experience—father and sons. While every dangerous moving part has been guarded, the guards have been hinged or made otherwise easily removable so as to cause the minimum of inconvenience to the operator.

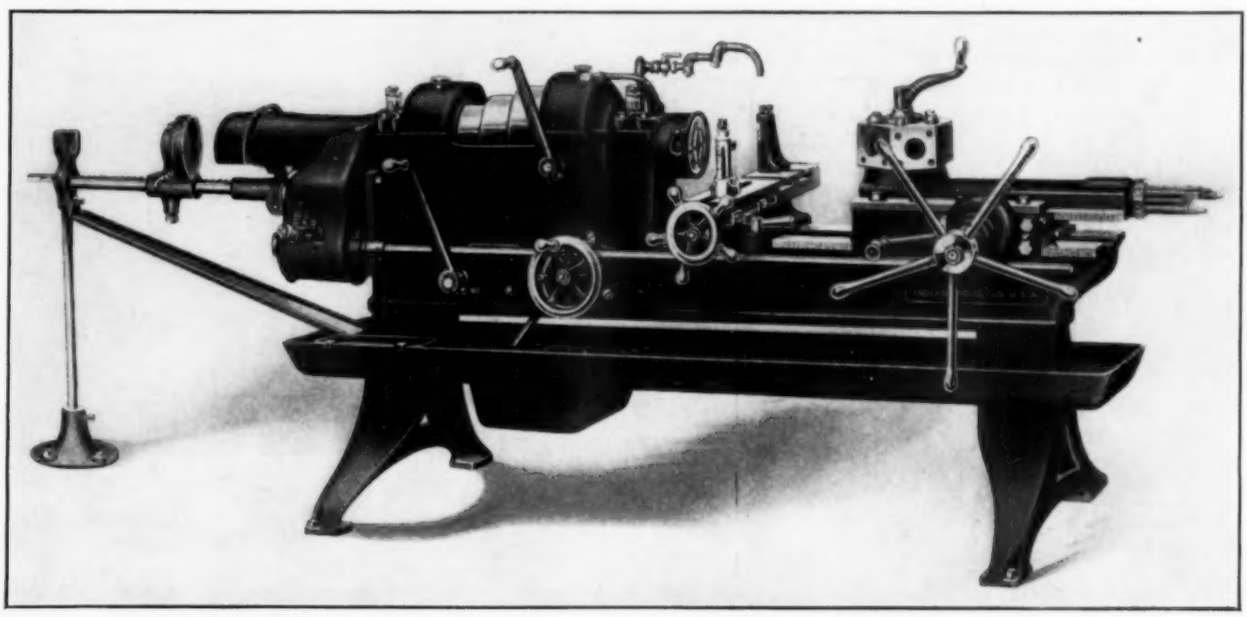


FIG. 1. THE MILLHOLLAND TURRET LATHE, INCORPORATING SEVERAL INTERESTING FEATURES

Taking up the description of the various parts of interest, the headstock, shown in detail in Fig. 2, has a three-step cone pulley and double friction back gears in addition to the friction between the cone pulley and the drive gear. This combination gives nine spindle speeds, with three speeds available without shifting a belt. The steps of the cone pulley are of large diameter, wide face and so proportioned as to transmit the maximum power with the proper spindle speeds. Die-cast bearings are used throughout, as indicated in the illustration. The solid, high-web type of casting makes a rigid form of head.

The spindle is forged from high-carbon steel and ground to size. The bearings are die-castings of a special high-grade babbitt and are carefully scraped and fitted. They are of generous proportions. Sight-feed oilers are provided for lubricating. The spindle nose is of large diameter, threaded and provided with a pilot end. It is so constructed that the overhang for either bar chuck or casting chuck is reduced to a minimum. Adjusting collars with hardened and ground thrust washers are provided to take up the end thrust.

The automatic chuck and bar feed, operated by the long lever shown on the front of the bed just below the headstock, grips or releases the work instantly. One movement of the lever opens the chuck and feeds the bar without stopping the machine. A stepped wedge, shown in Fig. 3, operating the fingers automatically compensates for slightly varying sizes of stock. The ends of the fingers are fitted with rollers to reduce the friction. The bar chuck is provided with a master collet of the push-out type, adapted for taking bushings for different diameters of stock. The bushings can be changed without unscrewing the collet hood by inserting a socket wrench through the opening in the hood and loosening the screws that hold the bushings in place. The collet hood, master collet and bushings are hardened and ground to gage, so that they interchange and can be duplicated whenever required. Extra capacity chucks or fixtures can be readily attached to the spindle nose in place of the collet hood.

Feed Box, Cutoff Slide, Turret Slide and Saddle

The gears in the feed box are of heat-treated steel. Eight different feed changes are available. Four changes are obtained by means of the tumbler lever, and these are doubled by means of the pull pin at the end of the feed box, as shown in Fig. 4. This illustration is a detail view of the complete feed-box layout and connections.

The cutoff slide and the accompanying mechanism, shown in Fig. 5, have broad flat bearings well gibbed to insure rigidity under heavy forming and turning cuts. The hand longitudinal adjustment is provided with a large-diameter dial and with adjustable clips, so that different shoulder lengths can be accurately duplicated. This illustration also shows a cross-section of the bed.

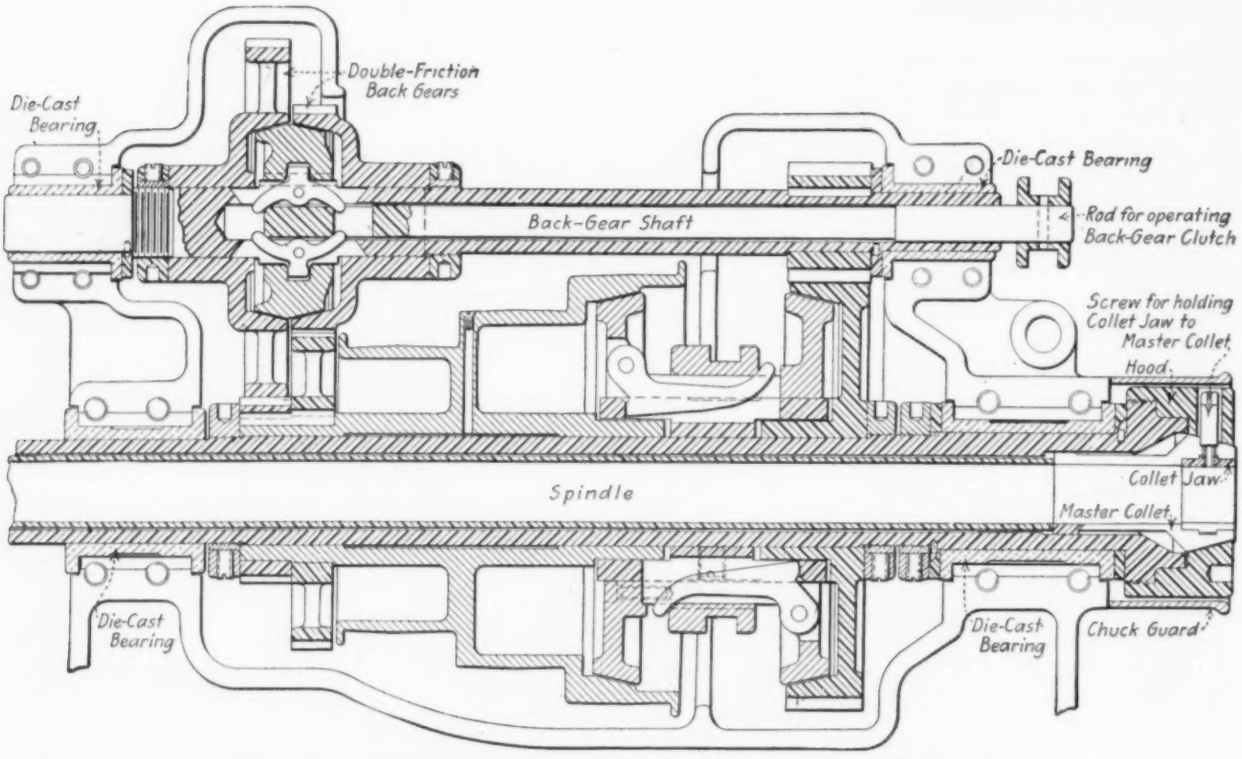


FIG. 2. PLAN VIEW OF HEADSTOCK OF MILLHOLLAND TURRET LATHE

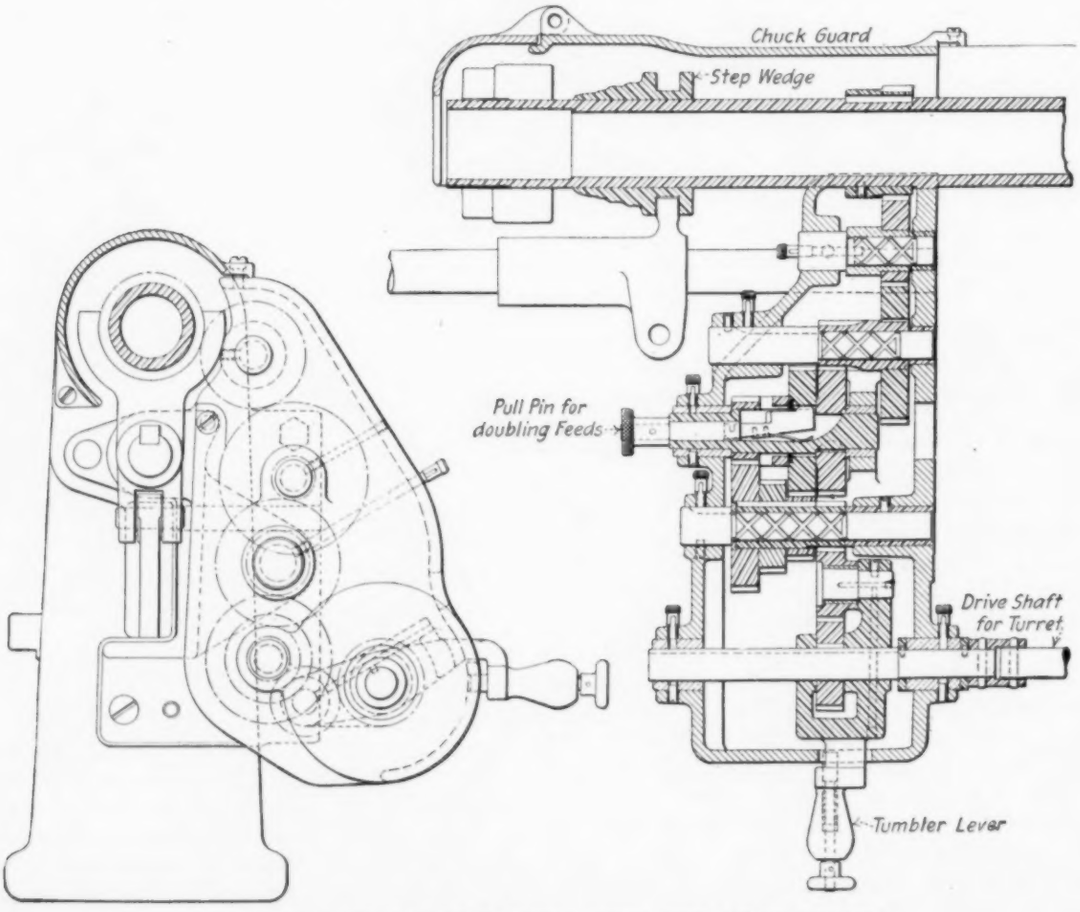


FIG. 4. THE FEED-BOX MECHANISM, WITH OPERATING DETAILS

The turret-slide and saddle unit, shown in Fig. 6, is provided with a supplementary taper base and taper gibs for vertical and horizontal adjustment. The turret is a solid hexagon, though a hollow hexagon will be furnished on order. The turret slide is operated by a turnstile rack and pinion. The turret is automatically indexed by the backward movement of the slide and is held firmly in its seat by the large steel stud upon which it revolves. This stud is tapered, is provided with adjustment for taking up wear and is bored so that long stock can pass through the turret, thus allowing long stiff tools to be used. The lock bolt is made of special steel, hardened, ground and lapped. It is operated vertically and locks into tapered holes in the hardened and ground steel bushings. The locking takes place at the front end of the slide almost directly under the working tool.

The tool holes in the solid-hexagon turret are regularly $1\frac{3}{4}$ in. in diameter, with binder bushings for holding round-shanked tools. Each face of the turret also has four tapped holes $\frac{9}{16}$ in. in diameter for tool-bolting purposes. The tool holes may be bored to any specified sizes. The turret feed is engaged by a friction clutch, and the lever for engaging the feed is located in the most convenient place for the operator. Eight feed changes, obtained through the feed box as previously mentioned, are automatically tripped by the independent adjustable stops. These stops operate automatically for each position of the turret. They are threaded their full length and are readily adjustable for the length of each cut to be taken. Each stop is provided with a binder for clamping it in position when set.

The oil pan is of pressed steel, to eliminate the possibility of breakage. The oil reservoir is of cast iron bolted to the pan and is fitted with a strainer to prevent chips from entering. A screw plug in the bottom provides

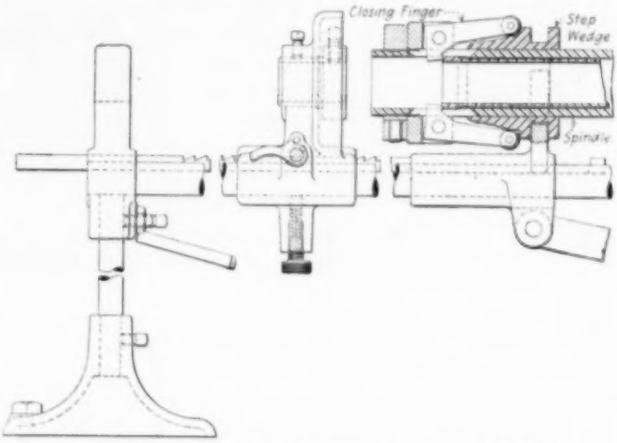
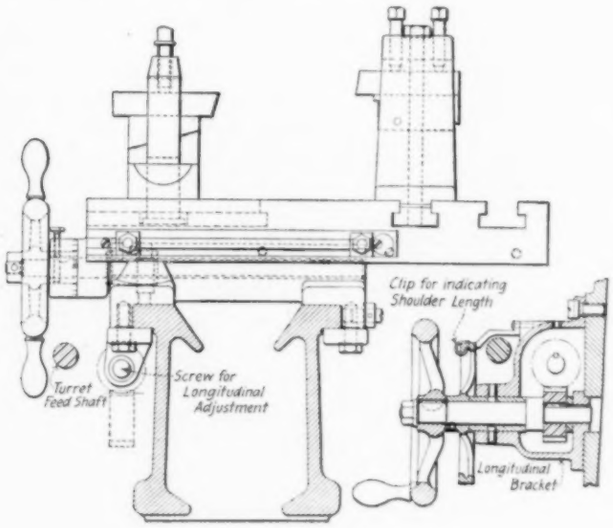


FIG. 3. REAR END OF SPINDLE AND BAR-FEED MECHANISM WITH AUTOMATIC CHUCK



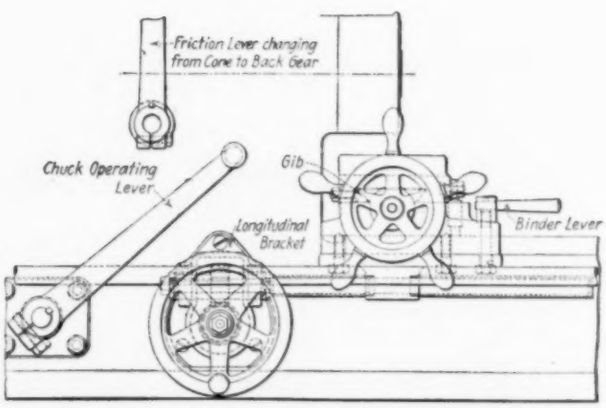


FIG. 5. OPERATING LEVERS AND CUTOFF SLIDE

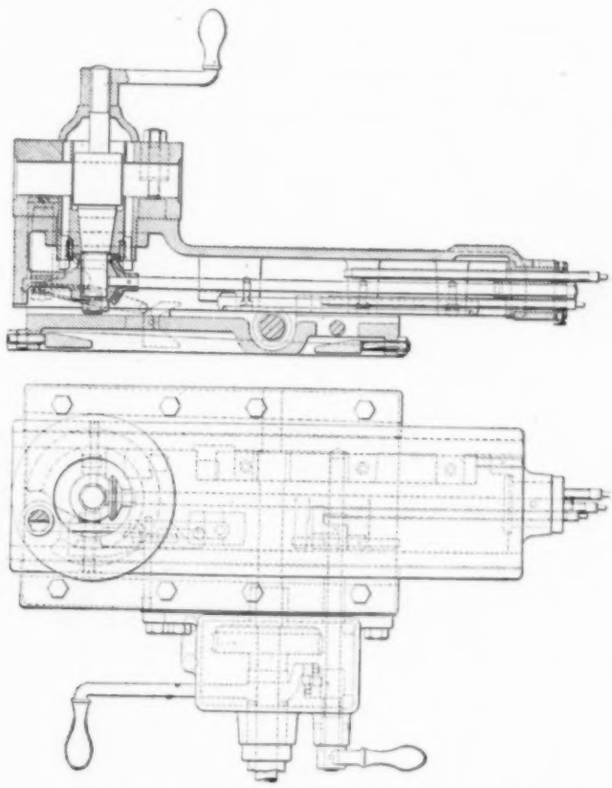


FIG. 6. DETAILS OF TURRET AND SLIDE

means of cleaning. A partition in the reservoir prevents sediment from entering the pump. The oil pump is driven by a belt from a pulley on the countershaft and operates when running in either direction. It delivers through two pipe lines. An item of construction worth noting is that the lagscrew holes are so placed in the legs that the screws may be put in with a socket wrench.

The principal dimensions of this machine are as follows: Swing over bed, 18 in.; swing over cutoff, 9 in.;

capacity of automatic chuck, 1⅝-in. round stock; size of hole in automatic chuck plunger, $1\frac{11}{16}$ in.; threading capacity on soft machinery steel, with self-opening die-head, U. S. Standard or Whitworth thread, 1½ in.; hole through spindle, $2\frac{1}{32}$ in.; diameter of thread on spindle nose, 5¼ in.; pitch of thread on spindle nose, 6; diameters of three-step driving cones, 8, 10 and 12 in., using double belt 3 in. wide; double back-gear ratio, 2.86 to 1 and 8 to 1; speeds, nine in number, ranging from 54 to 345 r.p.m.; total travel of crossfeed, 9 in.; total longitudinal travel, 11 in.; diameter of solid-hexagon turret, 9 in.; tool-hole diameter, 1¾ in.; size of tapped holes in turret faces, $\frac{9}{16}$ in.; feeds, eight, ranging from 0.0038 to 0.048; from center of holes in turret to top of slide, 3⅜ in.; effective turning movement of turret at any one time, 10 in.; greatest distance from face of automatic chuck to turret face, 27 in.; width of bed, 9 in.; double friction countershaft speed, 230 r.p.m.; friction pulleys, 12-in. diameter and 4-in. face; net weight, 2,500 lb.

Welding Sheet-Metal Parts with the Oxyacetylene Torch

The Terrell Equipment Co., Grand Rapids, Mich., makes a specialty of manufacturing sheet-steel parts. During the process of manufacture the welding torch plays an important part.

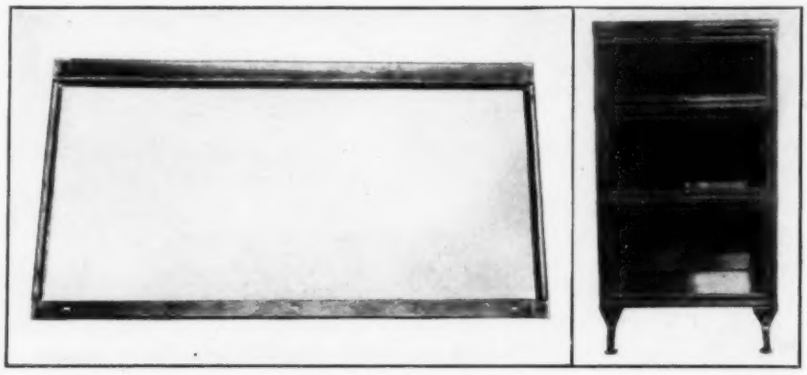
In Fig. 1 is shown a 12-in. wide by 60-in. high locker frame. This part is made from 1-in. wide steel, No. 16 gage thick. After the elements have been cut to length they are held in a fixture and the corner miter joints welded.

Description of Welding Fixture

A view of the fixture used when welding a 36x72-in. front cupboard frame, is shown in Fig. 2. It is made with right-angle supports *A* which line up the elements squarely. The clamp *B* is then fastened over the frame to hold the parts securely. It will be observed that the end of the clamp is made with a slot so that the flame can be directed near the joint when welding.

A view of the fixture set up on the stand with a frame in position is shown in Fig. 3. It will be seen that the fixture is placed at a convenient height for the welding operation. Under the table is a ball joint *A*, so that the fixture may be easily swung around to suit the operator.

The time required for making these four-corner welds is 1½ min., using a No. 3 tip, and the gas consumed is 0.23 cu.ft. of oxygen and 0.2 cu.ft. of acetylene.



FIGS. 4 AND 5. WELDED BOOKCASE TOP AND COMPLETE CASE

A Welded Bookcase Top and Welded Lockers

A bookcase top which has been welded is shown in Fig. 4. After the steel has been formed to the correct contour, size welds are made in each corner. The time required is 3 min. Using a No. 1 tip, the gases consumed are 0.17 cu.ft. of oxygen and 0.16 cu.ft. of acetylene.

A view of a finished bookcase is shown in Fig. 5. The upper section measures 24x10 in., the middle section 24x12 in.; the lower section is 24x14 in., and the depth is 12 in.

It will be observed that all the corner joints have been welded and the finished article presents a neat appearance, which would not be possible if rivets had been used.

A set of three lockers on which the welding torch has been used to advantage is shown in Fig. 6. Each section measures 15x12 in. by 72 in. high, and all the corners have been welded, as shown in a previous illustration. The gases consumed when welding this part are 9 cu.ft. of oxygen and 8 cu.ft. of acetylene, using a No. 3 tip.

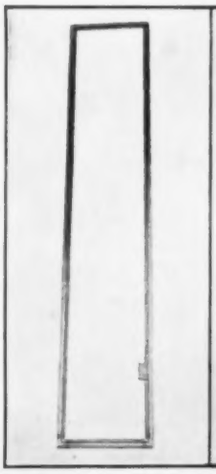


FIG. 1 WELDED LOCKER FRAME

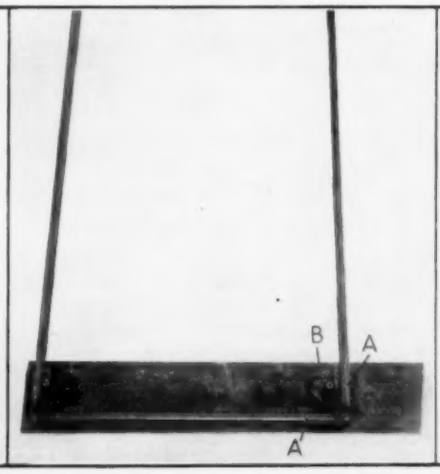


FIG. 2. THE WELDING FIXTURE IN USE

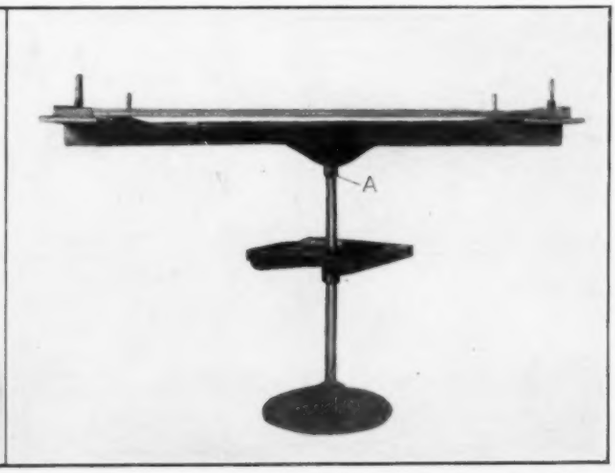


FIG. 3. THE FIXTURE SET UP IN POSITION ON THE WELDING STAND

It will be observed that the welded sheet-metal parts present a very neat appearance. It has also been found in practice that the joints made are amply strong for any strain put upon them and can also be made as quickly.

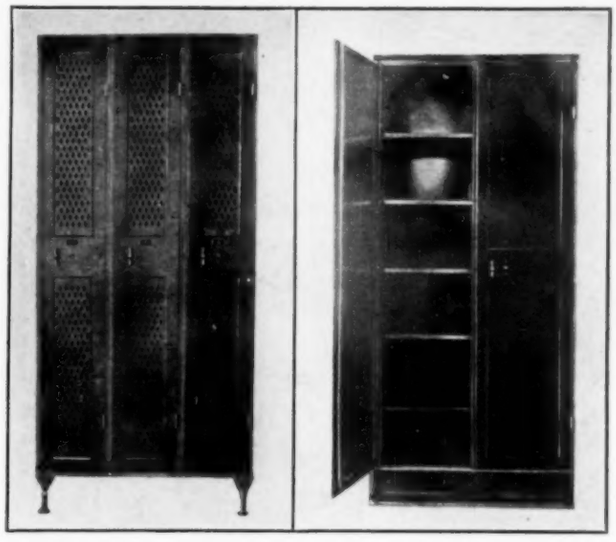


FIG. 6. SET OF WELDED LOCKERS

FIG. 7. A COMPLETELY WELDED WARDROBE

A welded wardrobe is illustrated in Fig. 7. It measures 36x15 in. by 72 in. high and has five shelves. All corner joints are welded. With a No. 1 tip the gases consumed are 3.5 cu.ft. of oxygen and 3.25 cu.ft. of acetylene. The apparatus is the Davis-Bournonville.

Designing Machinery Without Proper Shop Knowledge

By Frank C. Hudson

An old man I used to know in the shop always said that no man had any business in the drawing room until he had worked several years in the shop, and that even this was not always an excuse. And I'm inclined to

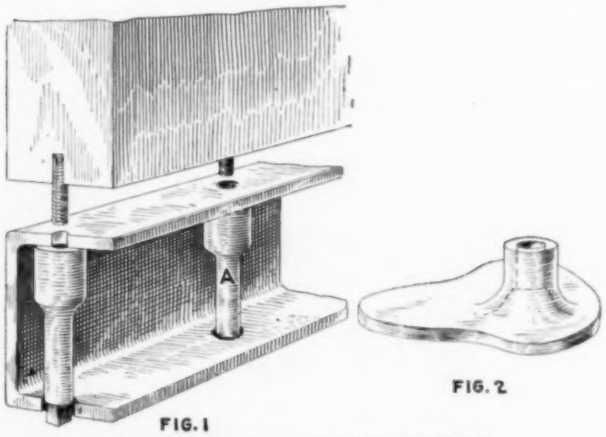


FIG. 1

FIG. 2

TWO EXAMPLES OF POOR DESIGN

agree with him. Not that shopwork makes an inventor, or even a designer, but it does show a man what sort of things can be made commercially in the shop. It teaches him to use a round hole that can be drilled instead of an oblong- or square-ended opening when the lathe is not absolutely necessary. A little study of some of the drawings for fuses which have been published shows very clearly that no shopman had a hand in designing them.

The automobile game has developed many examples of how not to do it, largely because the designers never worked in the shop and have no notion of how little things count in making repairs. In fact much of the designing seems to be done on the assumption that no repairs will be needed. Of course there is nothing like lofty ideals, but radiators will spring a leak, oil and water pumps clog and magnetos lose their "pep," once in a while. And when they do, it's mighty convenient to be able to fix them up without entirely dissecting the car, especially if it's a cold, stormy night and you are seven miles from nowhere.

I had a little cycle car come in for repairs the other day. It showed two examples of this kind. It is a good little bus and these defects in design do not interfere with its running. The radiator had an unhappy way of leaking pretty consistently, and while the soldering only took about 15 min. it took about 2 hr. to get the radiator off the car. Fig. 1 shows how it was fastened, but not how really difficult it was to take off. The channel is across the front of the car, with the opening at the rear, and here unfortunately are the motor and all its connections.

A man with a long, thin arm could just manage an open-end wrench and get about a sixth of a turn without hitting the pan or the side frame. It looked perfectly easy on the drawing board, but it's different in the garage. As the owner is a friend of mine and I'm likely to have this car come in again, I drilled holes in the bottom flange and made a couple of elongated nuts, as shown at *A*. These can be slipped through the lower flange before the radiator goes on and then screwed up from the front without any trouble. Of course the short studs could have been replaced by longer ones, but with my facilities the way shown looks the easiest for the job.

At the same time I found the front plate over the timing gears, Fig. 2, broken around the hub for the crank handle. This was a very thin plate of aluminum, while the hub was rather long and heavy. There was apparently no strain on it in starting the motor, but the hub broke off just the same. I welded it back in place very neatly, using the oxyacetylene torch, and it is stronger than ever, as I ran in quite a large fillet. The two sections were too unlike to be together, particularly in aluminum. It's a safe bet the designer never worked in the shop.

Influence of Oxidation on Steel—The extent to which steel is subjected to oxidation during its manufacture influences the tendency to unsoundness. In general, it was stated in a paper presented before the International Engineering Congress, the bessemer process oxidizes the steel to the greatest extent, the open-hearth process to a less degree, the crucible process to a still less degree and the electric-furnace process least of all. The processes by which the steel may be made and their more marked characteristics are shown in the accompanying tabulation.

Process	Nature	Remarks
Bessemer (generally baby vessels)	Acid	Very oxidizing
Openhearth	Basic	Generally thought to be less oxidizing than the bessemer
Openhearth	Acid	Less oxidizing than either of the above
Crucible	Acid	Hardly oxidizing at all
Electric	Acid Basic	Not oxidizing. Oxidation of steel made by other processes may be corrected by final treatment in the electric furnace

Machining Details Used on a Two-Sheet Rotary Press

SYNOPSIS—When machining the vibrating-roll side frame the operations are performed on jigs designed to hold right- and left-hand parts.

The two-sheet rotary printing press described on page 58 is made by the United Printing Machinery Co., Woonsocket, R. I. On page 56 were shown some of the jigs and fixtures used in manufacturing the press. In this article are shown tools used for machining four other details used on the same printing press. It will be observed that these like those shown in the preceding article are examples of high-grade special small-tool jig and fixture design and construction used in a modern shop.

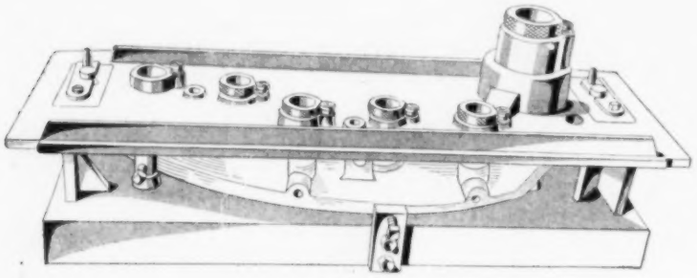


FIG. 2

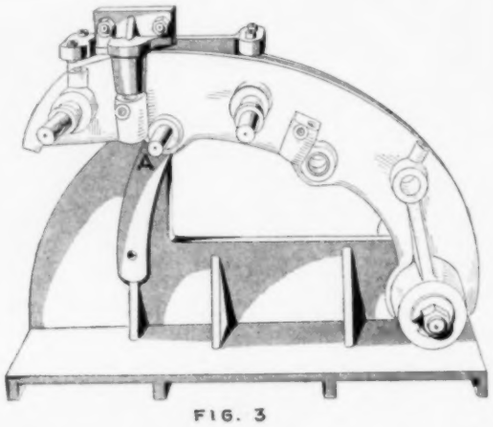


FIG. 3

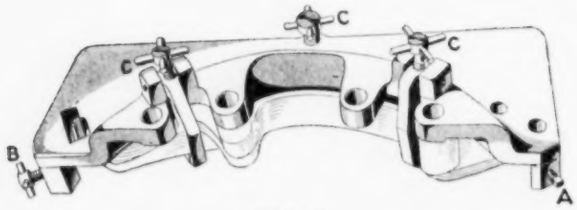


FIG. 5

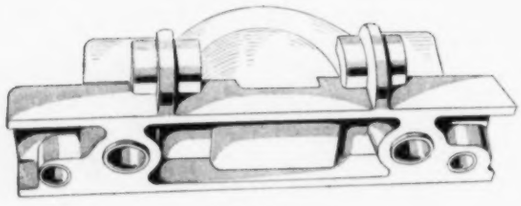


FIG. 7

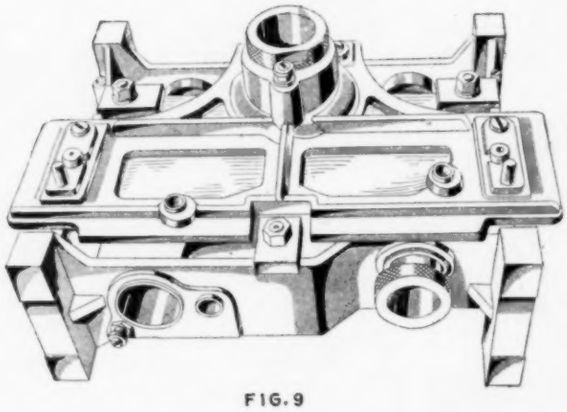


FIG. 9

DETAILS OF JIGS USED IN MACHINING PRINTING-PRESS ELEMENTS WITH THE WORK IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling holes in face of vibrating-roll side frame, Fig. 1. The casting is forced against the locating screws with setscrews and held down with a clamp. The cover is then placed over the casting. The pin A and the jig plate are dropped into the second position B for the second setting.

Holes Machined—One 2 11/32-in. drilled and reamed 2 3/8 in., five 1 11/32-in. drilled and reamed 1 3/8 in., two 1 3/32-in. drilled and reamed 1/2 in.

FIGS. 3 AND 3-A

Operation—Drilling holes in edge of vibrating-roll side frame. The castings, one right-hand, one left-hand, are located by plugs A fitting in holes reamed in previous operation.

Holes Machined—Three 1/2-in. drilled.

FIGS. 5 AND 5-A

Operation—Drilling all holes in form-roll socket-holder frame, feeder side, Fig. 4. The milled casting is forced against the adjustable screw A with the pin screw B and held in position with the hook bolts C.

Holes Machined—Eight 11/16-in. drilled and two 13/16-in. drilled. The former holes are then tapped with 3/4-in. threads and the latter with 7/8-in. threads.

FIGS. 7 AND 7-A

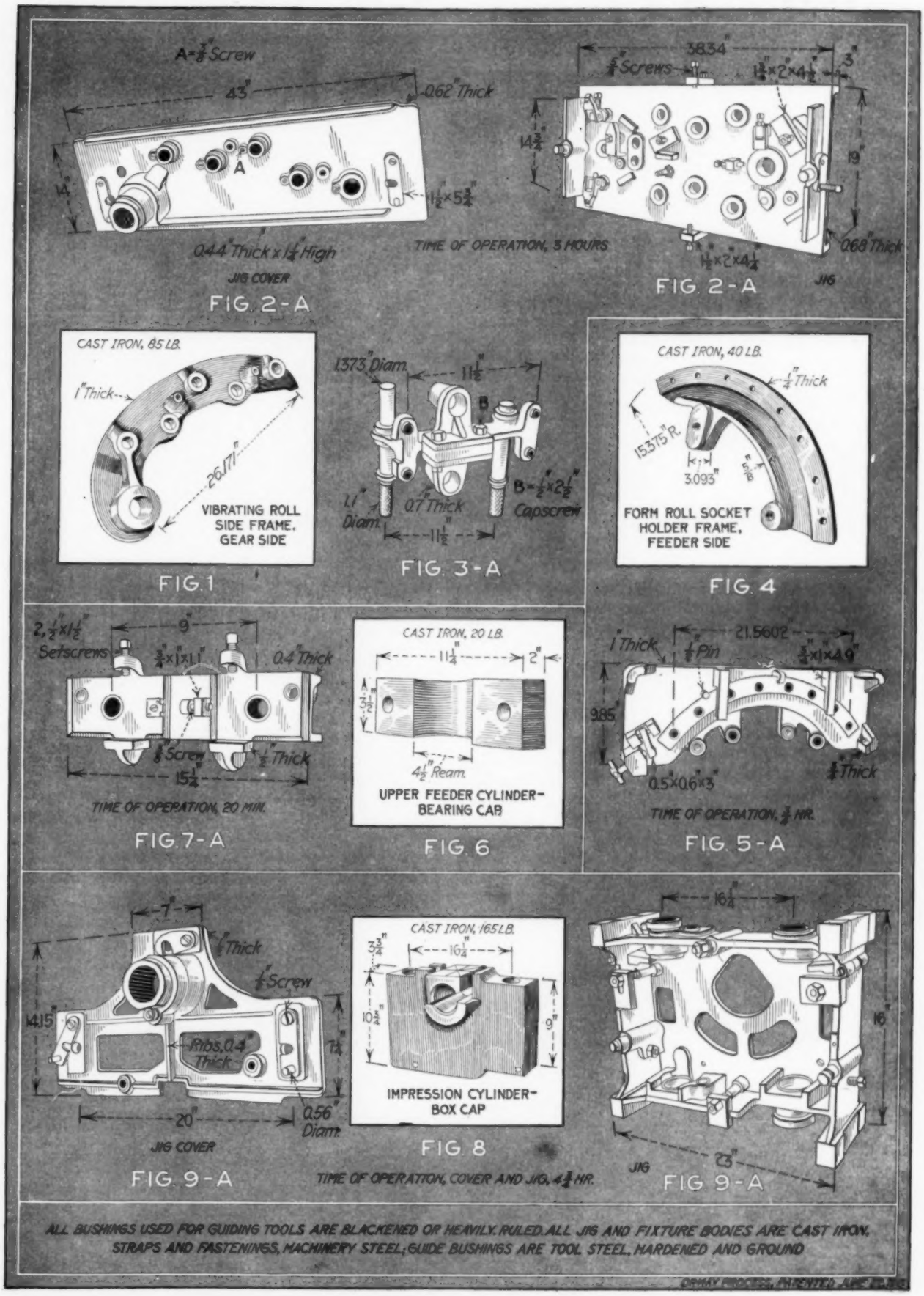
Operation—Drilling holes in upper feeder cylinder bearing cap, Fig. 6. The milled casting is located in the jig against a steel plate, being forced back with a knurled-head screw. It is held in position with two setscrews forcing it against the pads on the side.

Holes Machined—Two 1 3/32-in. drilled.

FIGS. 9 AND 9-A

Operation—Drilling all the holes in the impression-cylinder box cap Fig. 8. The casting has been milled in a previous operation. The piece is then located in the jig against adjustable screws, being forced back into position by setscrews placed on the opposite sides of the jig. The jig is fitted with three straps and after the casting is located these are tightened over it to hold it securely in position. The cover of the jig is then placed over the casting, being located by two dowels. Open side plates are then swung over shoulders on the locating dowels to hold the cover in position on the jig while machining.

Holes Machined—Two 5/8-in. drilled and reamed, afterward being spot faced 1 3/8 in., two 2-in. drilled and reamed, two 2 1/16-in. drilled, one 1-in. drilled, reamed and 1 1/4-in. counterbored, one 2 1/2-in. drilled and reamed



DETAILS OF JIGS USED IN MACHINING PRINTING-PRESS ELEMENTS

Molds for High-Grade Silverware

The H. O. Rogers Silver Co., Taunton, Mass., manufactures a variety of high-class silverware. In Fig. 1 is shown a candelabrum, and the molds used and the manner in which they are made are here described.

The first work is the designing, which is done on paper. After the design has been approved, the workman builds up with plaster of paris the different molds. These molds are smoothed off until they are of the correct contour to suit the designed part. In Fig. 2 are shown the plaster of paris molds for the base of the candelabrum. After being smoothed, they are sent to the foundry, where they serve as patterns for brass molds.

Preparing the Metal Molds

The metal molds are filed and smoothed until a part can be cast with the required thickness of wall. Those for the base are shown in Fig. 3. At *A* is shown the lower part, and at *B* may be seen the metal core, which is made in two parts so that it may be easily removed.

The upper part of the mold is shown at *C*. The air, or vent channels, may be seen in the parts *A* and *C*. Dowels are used so that the mold will line up in the correct position. One of the cast bases before the "fins" have been removed may be seen at *D*, and at *E* one after they have been taken off.

The Metal Molds Used for the Cups

The metal molds used for the candle cups and other pieces are shown in Fig. 4. When making hollow parts such as *A*, the metal is poured into the mold. After sufficient time has elapsed to allow the wall to solidify, the rest of the metal is poured out.

The time necessary can be estimated only by practice and experience. If the metal is not allowed to remain long enough, the walls will be too thin; on the other hand, if too long a time is allowed, the walls will be thicker than desired and the part produced will be heavier than planned and will contain too much metal.

In Fig. 5, at *A* is shown the fixture used when bending the scroll *B*. The bar is bent between the guide plates on the fixture, and the elements afterward soldered together in order to form the completed scroll as shown.

The mold for the lower part of the candle cup is shown at *C*, and one of the tubes which has been cut to length, at *D*. One of the candle cups and half of the metal mold are shown at *E*. The other cups are similarly molded.

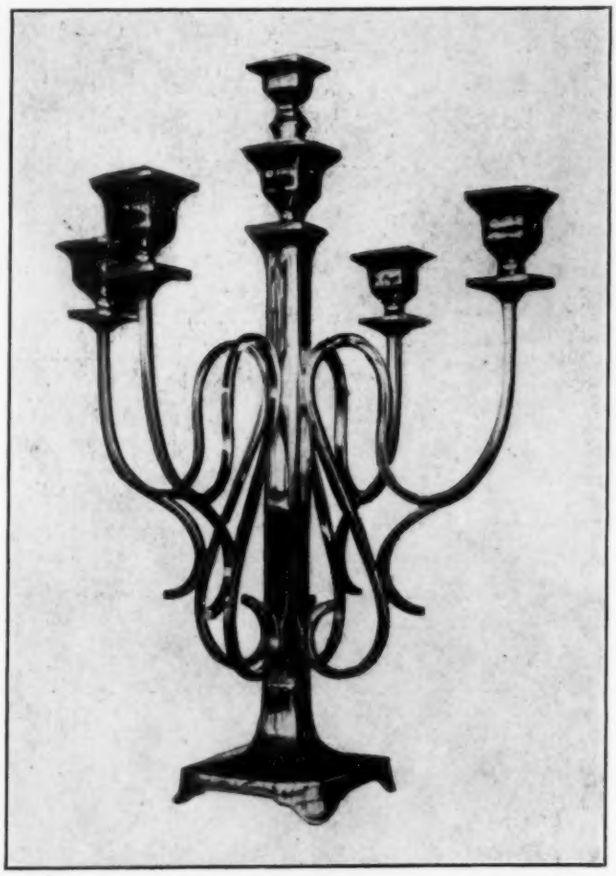


FIG. 1. A SILVER CANDELABRUM

After the parts have been made, they are united by soldering and the piece polished until the desired finish is obtained. The polishing operations follow the usual practice of silverware manufacturers.

When making the molds the die maker uses quite a variety of tools. This is necessary, as the shapes made

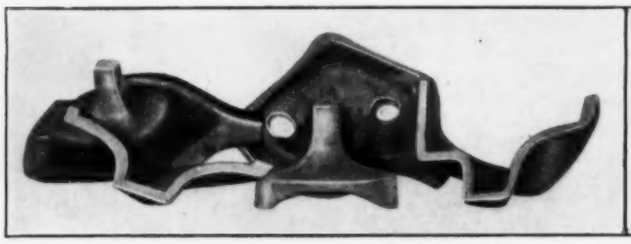


FIG. 2. PLASTER MOLD FOR BASE

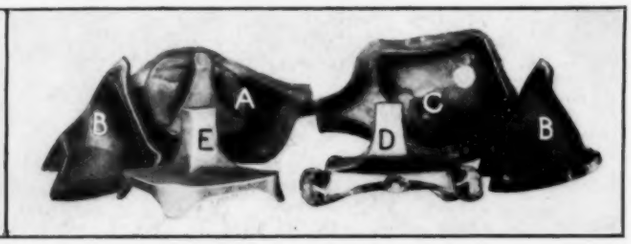


FIG. 3. METAL MOLDS FOR BASE

FIG. 4. MOLDS FOR THE CUPS

FIG. 5. THE SCROLL AND TUBE ELEMENTS

are often intricate in design. In Fig. 6 at the right is shown a box of tools used by the die maker at the factory. At the left of the illustration is shown one of

FIG. 6. BENCH AND TOOLS USED

the metal molds held in a special fixture which may be revolved, thus enabling the man to chip or file conveniently any surface as desired.

An Electrical Limit Gage

By George H. Cheney*

A short time ago it became necessary for me to design a gage to be used in gaging finished push rods, which it was necessary to test for size, taper and roundness with a tolerance of 0.0005 in. for each. The gage in use for this was the best type I knew of, being a built-

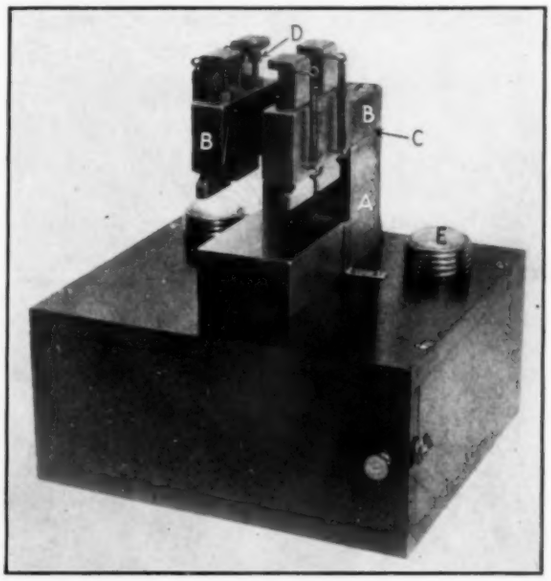


FIG. 1. ELECTRICAL TESTING GAGE FOR PUSH RODS

up snap gage composed of a central block which was lapped to an exact low limit with plates bolted on each side, one being flat and the other with a step the height of the limit allowed.

This gage was easily repaired as the central sizing block was not affected by wear, and it was a simple matter to lap the plates flat when they became worn. But as there were from 3,000 to 4,000 pieces to be gaged daily, the time consumed in testing the parts and repairing the gage was considerable.

Consequently I looked for a fast, accurate method of doing this work and decided to make a test of an electric contact gage. For this purpose I took a U-shaped forging with an insulated screw in one side to determine how much gap a low-voltage current would jump, and found that with three dry cells it was necessary to have actual contact to light a lamp.

In making this test I used very accurate testing blocks and found one which showed a taper; one end would light the lamp, and the other would not. I tried this repeatedly with the same result, but could find this taper in no other way, thus indicating the sensitiveness of the device. From these tests I designed the gage as shown.

It consists of the base *A*, as shown in Fig. 1, upon which are mounted the two arms *BB*, being insulated at

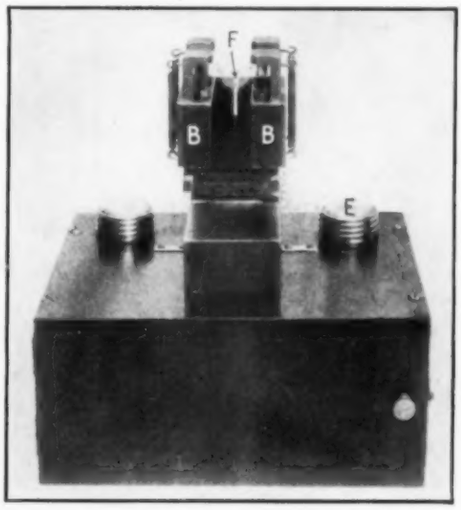


FIG. 2. FRONT VIEW TO SHOW SEPARATION OF POLES

C. The four contact arms, which have a vertical movement in the arms *B*, are held down by springs on the adjusting screws shown at *D*. Fig. 2 shows the space *F* between the two arms *B*.

The supporting box contains the dry cells, one pole being connected to the base *A*, Fig. 1. Two wires are run from the other pole to the two arms *BB*, with one of the lamps shown at *E* in series with each. The lamps are the heads of an ordinary flashlight.

The contact arms have a face equal in length to approximately one-third the circumference of the work. The two front contact arms are now set to the high limit and the two rear ones to the low limit allowed.

It will readily be seen that if a piece of work touches the base and any contact arm, it will close the circuit and light a lamp. Therefore if we roll a piece under the front arms and it lights either lamp, there is a spot on the piece over size; likewise if we roll a piece under the rear arms without lighting both arms, there is a spot under size, the right or left lamp indicating which end is incorrect.

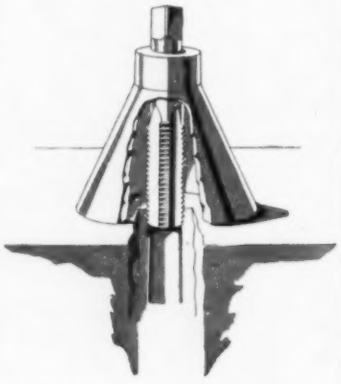
As the springs used are very light, just enough to insure the return of the arms should they be lifted by an oversize piece, there is very little wear. The faces of the arms and the base must of course be lapped perfectly parallel. This furnishes the most accurate sensitive gage I have ever found.

*Superintendent of tools, the Studebaker Corporation.

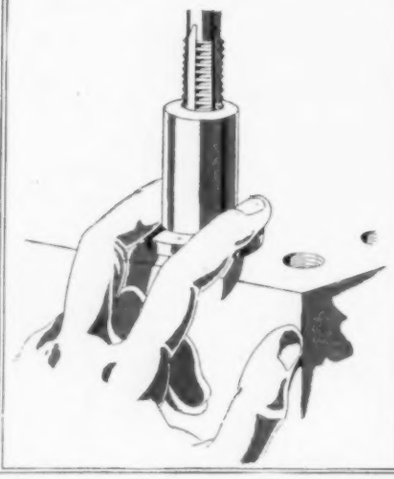
From A Small-Shop Notebook

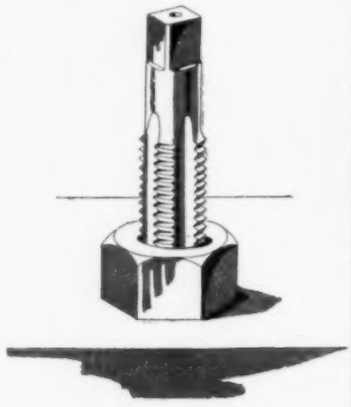
By John H. Van Deventer

Three Devices That Square Up a Hand Tap



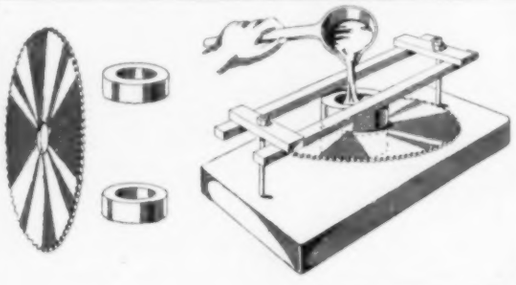
Makes it easy to start a tap square with the work.





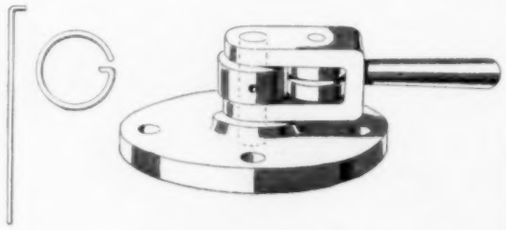
A faced nut will do when nothing else is at hand.

Easy Local Annealing of Saw Blades



Melted lead does the job so one can file a keyway.

Simple Hand Fixture for Wire Rings



This device will take up little room and pays rent.

Making an Accurate Templet

Small errors can be seen easily through the glass.

A Pipe Wrench for Emergencies

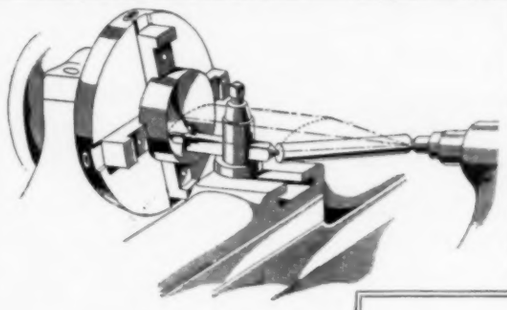
A bit of round file blade or a short stud will do as well.

Oil Grooving with Twist Drill

An electric or air drill will make oil grooves in jig time.

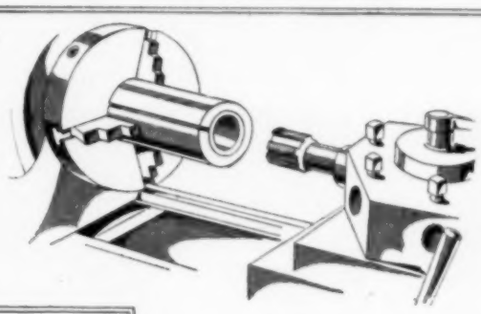
BENCH, VISE AND ASSEMBLING METHODS

Turning a Concave Surface



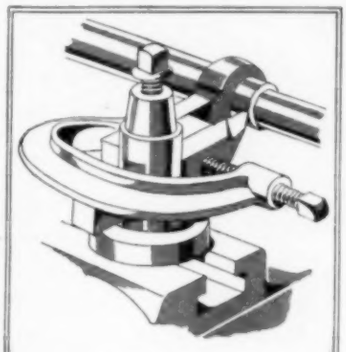
A mandrel with large centers is all of the rigging needed.

A Thin Tube Tapping Kink



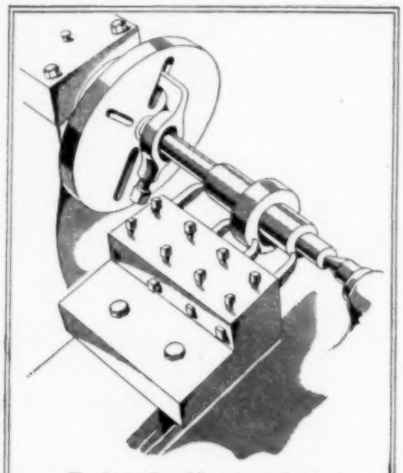
Thin tubes chucked like this will tap without distortion.

A Follow Rest for Smooth Stock



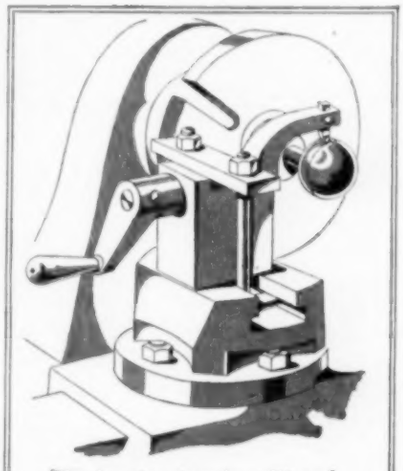
Good for springy shafts.

Multiple Facing Tools in Lathe



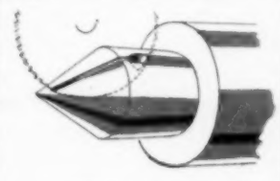
Facing shoulder lengths on a quantity of duplicate pieces.

Simple Ball-Turning Fixture



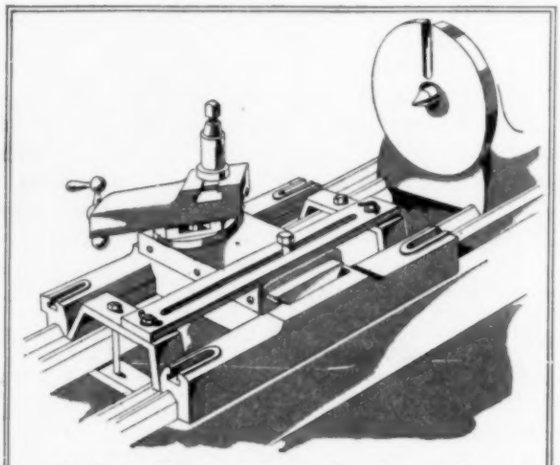
The bearing box is split and clamps the tool to its cut.

Self-Lubricating Tail Center



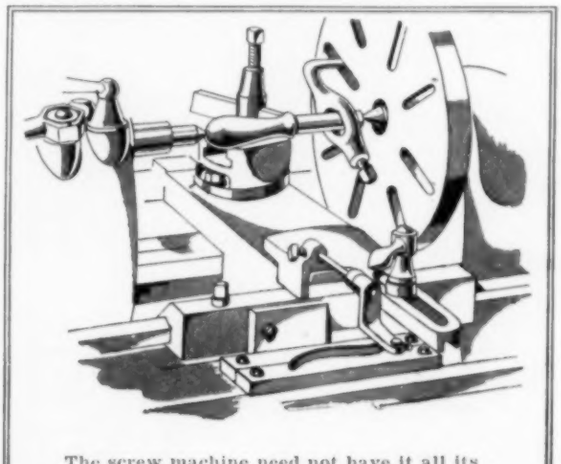
Will not heat or cut.

Rigging Up a Taper Attachment



Lathes without taper attachments can be made more flexible by using this rig.

Form Turning in the Engine Lathe



The screw machine need not have it all its own way in the form turning of steel.

DEVICES THAT MAKE LATHES PROFITABLE

Special Punch-Press Fixture

By E. V. Allen

The fixture shown in Figs. 1 and 2 is used in the shop of the Indiana Lamp Co., Connersville, Ind. The main part of the fixture is bolted solidly to the column of the press, but the central part may be removed and other die-holding blocks put in its place. The die block is held so that on certain parts of lamp shells or bodies, where a number of holes are to be pierced from different angles, the central part may be indexed around. In the particular case shown, only one hole is pierced, as shown in the second illustration. The work is of course comparatively light, most of it being thin sheet brass.

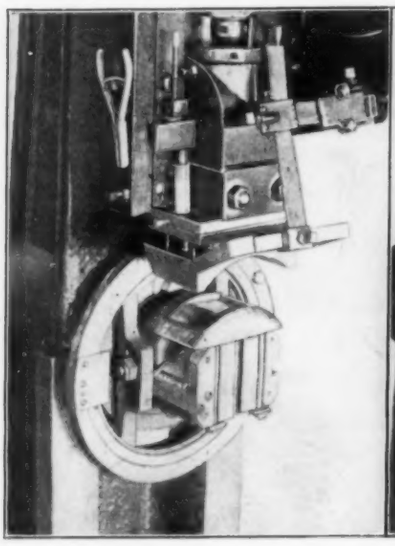


FIG. 1. SPECIAL PUNCH-PRESS FIXTURE

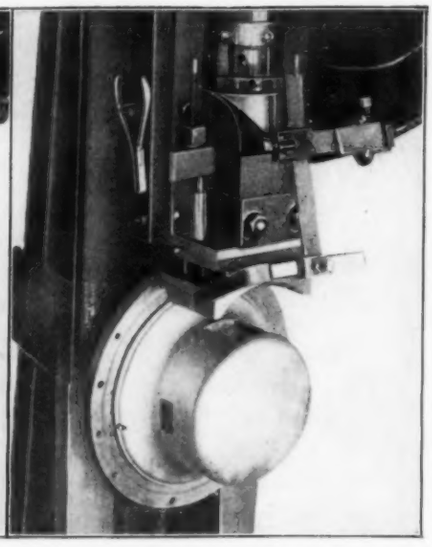


FIG. 2. FIXTURE WITH WORK IN PLACE

Training Men for Foreign Trade Service

A problem of commanding importance in the development of our international commerce is the education of men for foreign trade. It is absolutely necessary that we train men to carry on our foreign trade, for we find ourselves today without an adequate supply. This problem may be regarded as the very fundamental of success in this field. Our banks cannot establish branches because they have not the men with which to man them. Our manufacturers find it difficult to secure salesmen. Our investors cannot find competent advisers on foreign offerings.

Perhaps the most discouraging feature in this problem is that the leaders in our schools and colleges seem unable or unwilling to see the need, or having seen it are unable or unwilling to give the thorough instruction necessary. If ever the educator had a definite, concrete problem to solve, it is this. Up to the present time there are no appreciable results. Several of the commercial schools and colleges are giving excellent instruction to young men intending to engage in business in this country, and some are offering good courses in foreign trade. But these courses have not been grouped so as to give the all-round training necessary for success in export trade; the language work is inadequate, and no opportunity is provided to acquire the requisite practical experience.

At one institution a novel step has been taken and a promising plan is ready to be put into operation. New York University has announced the creation of a limited number of special business fellowships for the purpose of training men for foreign trade. These fellowships are awarded by business concerns to men selected from a large number of applicants throughout the country. The plan is to employ the men on a part-time arrangement in the New York offices of these concerns and let them spend the remainder of their time in study at New York University. During the summers, which would ordinarily be devoted to vacation, the men will be expected to devote their entire time to the work of the business concerns employing them. For this half-time work they are to receive from $60 to $75 per month, and the course of training will usually last three years, though each man must of course adapt his training to the need of his employers. It is also expected that the men will live in clubs located near the university, each club devoted to the study of one foreign language. During the coming year there probably will be 25 to 30 men studying and working on this basis, and a rapid increase in the number is expected in the future.

Other colleges and universities, even those having highly developed schools of business, are doing too little to train men for foreign trade. Perhaps this is to be expected, because the demand for such training is of recent origin. Nevertheless the mere offering of one or two courses on the subject of foreign trade, foreign tariffs or South America is absolutely inadequate. When compared with the thorough and careful training which Germany has given her foreign representatives, our work is lamentably inadequate.

It is also to be regretted that the actual work of instruction is not intrusted to men who have some practical or personal knowledge of the subject. A mere second-hand acquaintance, a mere book knowledge of foreign trade, is inadequate. I do not mean by this statement to advocate the employment of merely practical exporters as instructors. But I do advocate the employment of men who have gathered their facts and information by personal investigation and have thus acquired a first-hand knowledge and have a practical contact with the things which they propose to teach.—Report of Chief, Bureau of Foreign and Domestic Commerce.

The Consumption of Aluminum in the United States in 1914 was the largest on record and amounted to 79,129,000 lb., which is much greater than the output, and though some metal is exported, a much larger quantity is imported. The consumption of the metal is growing rapidly, and the facilities for turning out enough for home consumption are inadequate. When one considers the multiplicity of uses to which aluminum is now applied, and the part that it is destined to play, the question of the domestic supply of bauxite, the mineral from which aluminum is now made, assumes importance. So far as our present resources are concerned, we may consider the United States as practically independent, especially as new bauxite occurrences may be found, and American inventive genius may be trusted to solve the problem of extracting the metal from clay or some other aluminum compound.

Manufacturing British 18-Pounder High-Explosive Shells--III*

By E. A. Suverkrop

SYNOPSIS—The copper driving band near the base of the projectile performs a very important function. The lands of the rifling cut into it and cause it to rotate in the barrel of the gun. If it be rigidly fitted, it transmits its rotary motion to the projectile which it embraces. It also acts as packing and prevents the leakage of gas from the propulsive charge past the shell and the consequent loss of efficiency.

At the moment subsequent to the explosion of the propulsive charge the direction taken by the projectile is in a straight line without any rotary motion. Immediately the shell strikes the rifling, it is caused to

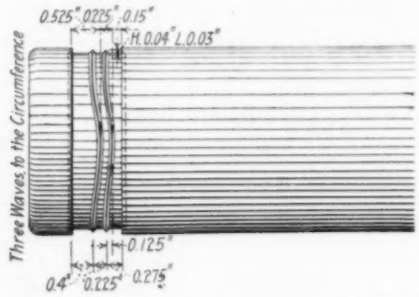


FIG. 25. WAVE RIBS FOR HIGH-EXPLOSIVE SHELL

rotate at a high rate of speed, and enormous stresses are instantly set up. To withstand these the metal used in the driving band and the mechanical means used for fastening it to the projectile must be adequate.

Copper seems to be the metal best suited for the purpose. It is soft, takes the rifling readily without eroding it excessively, yet is hard enough to resist undue wear itself during the short period of time that it is moving from the breach to the muzzle in contact with the rifling and bore of the gun. It is also tough enough to resist stripping either on the exterior where it is in contact with the barrel or on the interior where it is in contact with the projectile.

There are various ways of securing driving bands. In the Russian shell the bottom of the driving-band groove is knurled with a coarse knurl. In assembling, the band is compressed and the soft copper embeds itself in the knurling. In the French shell a series of serrations is turned in the bottom of the groove. When assembling the copper band in the French shell, the metal enters the serrations; but in this instance they are at right angles to the serrations made by the knurl in the groove in the Russian shell. The method of applying the driving band to British shells is much more elaborate. The groove is dovetailed on each side, and depending on the size of the projectile, two or more wave ribs, as shown in Fig. 25, are turned in the bottom. When the copper band is pressed on, the wave ribs embed themselves in the metal. The object sought by these various methods is to assure that, at the moment of firing, the friction between the band and the shell shall be sufficient to overcome the inertia of the shell and cause it to follow the rifling in a rotary as well as a forward motion.

Which, if any, of these methods of securing the driving band is the best is doubtful. There is, however, no doubt that the British method is by far the most difficult to manufacture.

The rough grooved shells from the fourteenth operation go to 20-in. by 8-ft. engine lathes, one of which is shown in Fig. 26. They are equipped with heavy combination chucks *A* to hold the shells and drive them. The base end of the shell is supported by the tail center. Mounted on the carriage of the lathe is a stop *B* which is so located that it brings up against the base of the shell between the edge and the riveting flange. This stop is fixed in the carriage and bears a positive position relatively to the undercutting attachment *C* on the front of the carriage, and also to the waving attachment on the back. The waving cam *E* is secured to the face of the chuck *A* in such manner that it does not interfere with the operation of the chuck.

Two types of undercutting attachments have been tried; that shown in Fig. 26 is a modification of the one designed by the Canadian Allis-Chalmers Co. and shown some time ago in the series of articles on the manufacture of the 4.5-in. high-explosive shell. The original undercutting attachment is shown in Fig. 27. It utilizes a

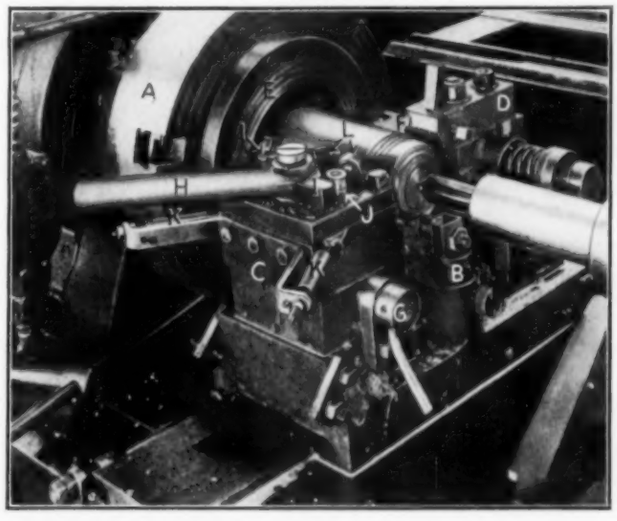


FIG. 26. WAVING AND UNDERCUTTING THE DRIVING-BAND GROOVE

formed cutter, as shown at *C*. By referring to Fig. 25 it will be noted that the space between the forward wave rib and the side of the driving-band groove at the narrow parts is only about one-tenth of an inch in width. As the undercutting tool must pass here, it means that it must be very delicate at this point. With skilled operators there would be little trouble; but as previously

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stated, many of the machine hands are unskilled, and the tools for their use must of necessity be as strong as possible.

The other type of undercutting attachment utilizes a pair of simple tools made from square steel, and while one of these must enter the same space as the formed tool, they are, owing to their shape, not so subject to breakage as the formed tool and when broken, are more easily put in working order again by grinding. In Figs. 26 and 27 similar parts are indicated by similar reference letters.

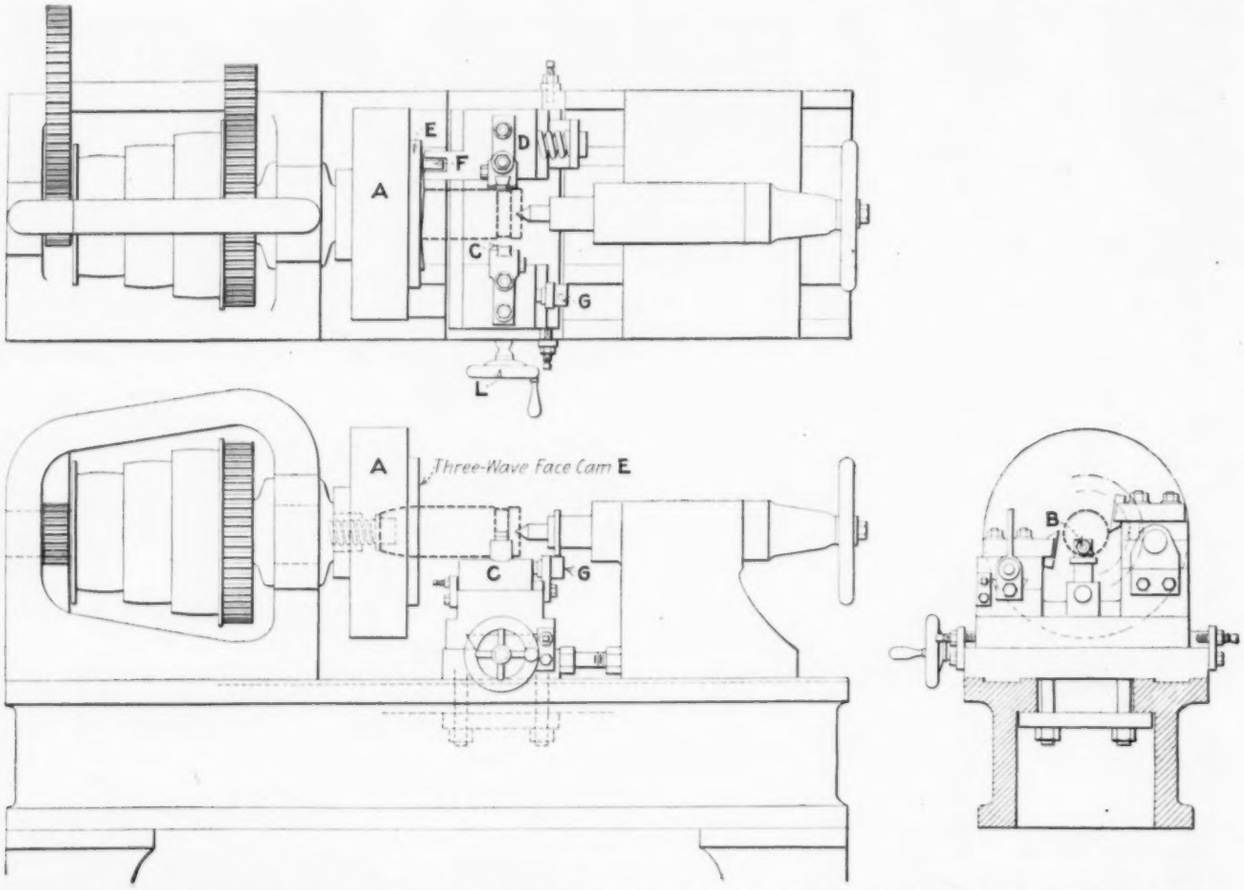


FIG. 27. ARRANGEMENT OF GARDNER 20-IN. BY 8-FT. ENGINE LATHES FOR WAVING AND UNDERCUTTING

The operations of undercutting and waving are performed as follows: The operator enters a shell in the chuck of the engine lathe. Inside the spindle and backed up by a stiff spring is a sliding plug. The nose of the shell fits over this. The rear end of the shell is located on the tail center, which is then run out, compressing the spring and holding the shell. The jaws of the chuck are now tightened on the body of the shell. The carriage is run forward till the stop *B* brings up against the base end of the shell, thus correctly locating the undercutting and waving attachments in relation to the rough-turned driving-band groove. The carriage is now clamped and the undercutting tool fed to the bottom of the groove, a stop controlling the motion of the cross-slide.

With the old style of undercutting attachment the tool was fed lengthwise of the lathe by means of the screw *G*, undercutting first one side of the groove and then the other. With the new style of attachment, shown in Fig. 26, the diagonally disposed tools are alternately advanced by operating the handle *H* first to the right and then to the left. The two lugs *I* contact with the pins *J* attached to the tool holders. The tool holders are returned by the springs *K*. Stops are provided at *L* to limit the forward movement of the undercutting tools. When both sides are undercut, the cross-slide is run back. This brings the waving attachment at the back of the cross-slide into operating position, with the roller *F* in contact with the wave cam *E*. While the waving tool is reciprocated by the cam and roller, it is fed to depth in the groove by the crossfeed screw, which in turn is controlled by the handwheel *L*. The scheduled output for undercutting and waving is 21 shells per hour.

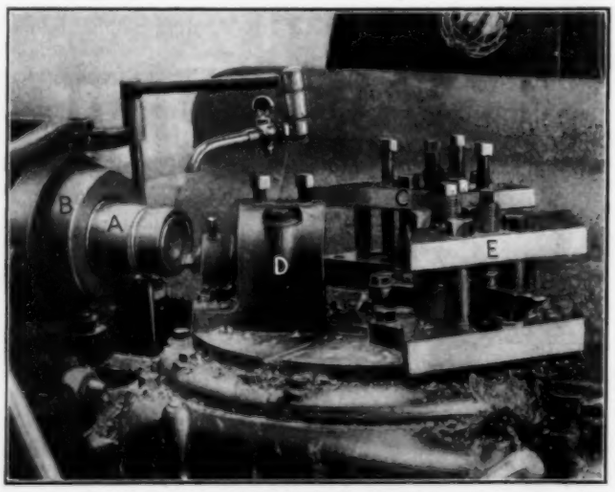


FIG. 28. RECESSING FOR BASE PLATE

After the wave is cut, a small thread-like ridge is left on one side of the driving-band groove. This is removed by a boy with a hammer and a chisel. This completes the fifteenth operation.

The inspection on this operation requires the same gages as the previous one. High- and low-limit snap gages

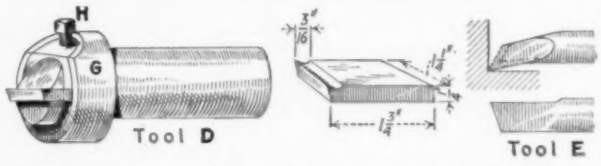


FIG. 29. ROUGHING AND FINISHING RECESSING TOOLS

for the diameter are 3.110 and 3.090 in. respectively; the distance from the base of the shell to the groove is 0.77 in. high and 0.73 in. low, and the width of the groove is 0.915 high and 0.885 low. Having passed inspection, the shells are credited to the operator, and the truck gang conveys the work to the next operation.

The sixteenth is another operation on which the Jones & Lamson flat turret lathes have been retained. It consists of forming the recess in the base of the shell for the reception of the base plate.

It is performed on 2x24-in. machines, as shown in Fig. 28. Three stations of the turret are used. The shell *A* is held in the regular Jones & Lamson collet chuck *B*. The first station *C* of the turret carries an ordinary stop. The second station *D* carries a flat recessing tool, and the third station *E* carries a single-pointed boring and facing tool.

The shell is entered in the chuck and lightly gripped. The stop in *C* is then brought forward, forcing the shell in the chuck to the correct depth; this is determined by the stop for the turret slide. The chuck is then fully closed. The turret is indexed and the tool in *D* brought to operating position. The turret is fed forward till the stop is reached. The tool used in *D* is shown in Fig. 29. Its body is made of machine steel and the inserted cutter of high-speed steel. The collar *G* prevents the holder from opening up when the setscrew *H* is tightened on the cutter. The tool is set so that it cuts from the center outward. It leaves the recess about $^1/_{64}$ in. smaller in diameter and the same amount shallower than final size.

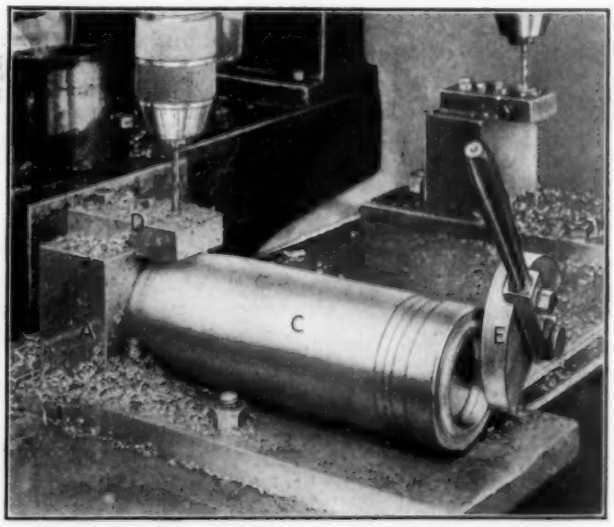
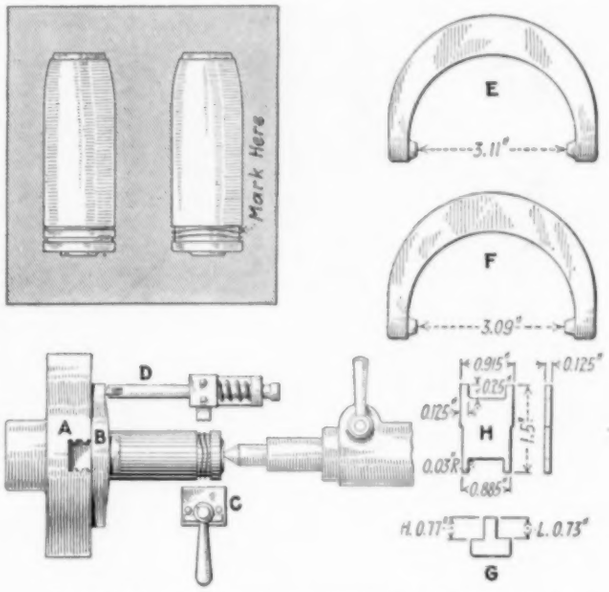


FIG. 30. DRILLING FIXING-SCREW HOLE

The third station of the turret carries a combination boring and facing tool, which is also shown in Fig. 29. The operator sets the head of the machine over to bore the correct diameter. The turret is fed by hand till the stop is reached. The turret is then clamped and the crossfeed on the head thrown in to face the bottom of the



OPERATION 15. UNDERCUTTING AND WAVING

Machines Used—20-in. by 8-ft. engine lathes.
Special Tools and Fixtures—Universal chuck A. Waving cam B. Undercuting attachment C. Waving attachment D.
Gages—High and low snap gages E and F. Gage G, distance from base to driving-band groove. Gage H, width of driving-band groove.
Production—One man and one machine, 21 per hr.
Note—Cutting compound used.
References—See Figs. 25, 26 and 27, also Fig. 10, for position of inspector's mark.

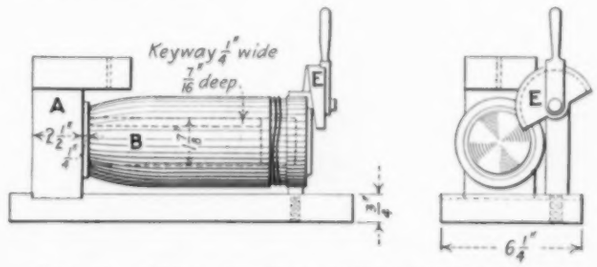


FIG. 31. DRILL JIG FOR FIXING-SCREW HOLE

recess. The scheduled output for the recessing operation is 25 pieces per hour.

Inspection covers the thickness of the base of the shell measured from the bottom of the hole in the shell to the bottom of the base-plate recess and the diameter and flatness of the bottom of the recess. Those shells which pass inspection are stamped in conformity with the standard marking chart, Fig. 10, the checker credits them to the operator, and the truck gang delivers them to the next operation.

Drilling and Tapping the Fixing-Screw Hole

The seventeenth operation is done on sensitive drilling machines handled by boys. It consists of drilling a hole, ¼-in. tapping size, for the fixing screw. The outfit used is shown in Figs. 30 and 31. The jig *A* is, like all the other tools used in this shop, very substantial in construction. In this respect it compares favorably with a jig used for the same purpose in another factory. This

latter jig is a simple V-block made of wood. As the nose of the shell is coned and the hole to be drilled is beyond the parallel part of the shell body, the work has to be held down by the operator. The distance from the nose of the shell to the fixing-screw hole must be within close limits, and a wooden jig is not sufficiently positive for

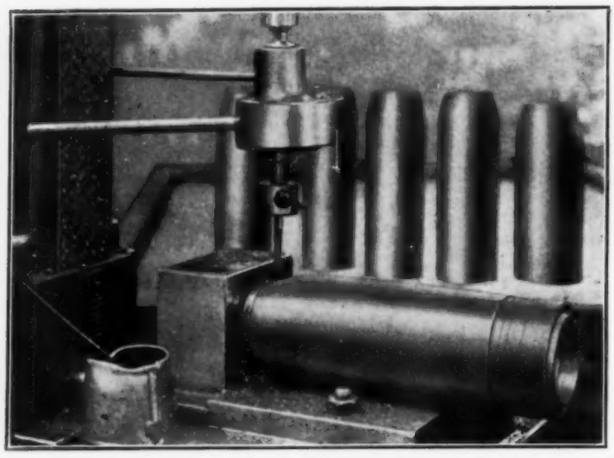
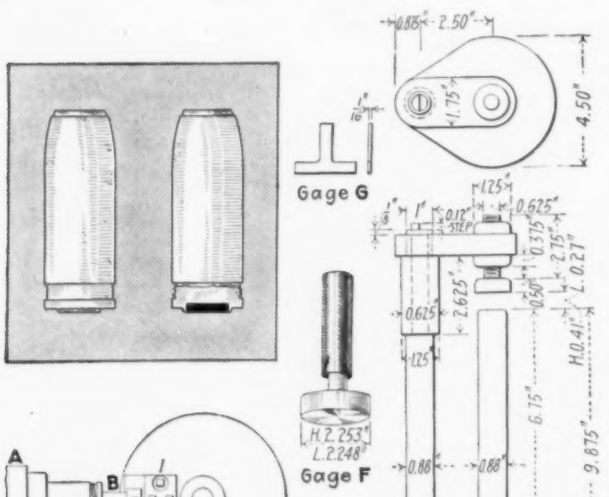


FIG. 32. TAPPING THE FIXING-SCREW HOLE

the work. The chips and the handling of the work into and out of the jig cause excessive wear, so that wood for even a simple jig like this is unsuitable. The foregoing is intended in the nature of a warning.

The base *A* is made of cast iron and carries a horizontal post *B* which is an easy fit for the hole in the shell. A keyway or slot runs along the top of *B* so that the burrs caused by drilling will not jam when the work is removed. It must be remembered that owing to wear on the boring tools and other conditions in the boring operation, the holes are not all of exactly the same size; for this reason the post *B* must be of such size that it will fit the smallest acceptable size of hole. Mounted on the base at the rear end of the shell is a vertical member which carries a circular wedge *E*. This is used to force the shell against the vertical member of *A* which acts as a stop and also prevents the shell from shifting during drilling. The



OPERATION 16. RECESSING BOTTOM OF SHELL FOR THE BASE PLATE

Machines Used—Jones & Lamson 2x24 flat-turret lathes.
Special Tools and Fixtures—Jones & Lamson collet chuck A. Stop B. Recess roughing tool C. Finish-boring and facing tool D.
Gages—Gage E, thickness of base. Gage F, diameter of recess. Gage G, flatness of botom of recess.
Production—One man and one machine, 25 per hr.
Note—Cutting compound used.
References—See Figs. 28 and 29, also Fig. 10, for position of inspector's mark.

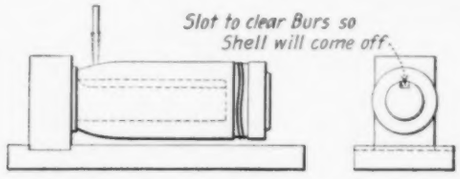


FIG. 33. THE TAPPING FIXTURE

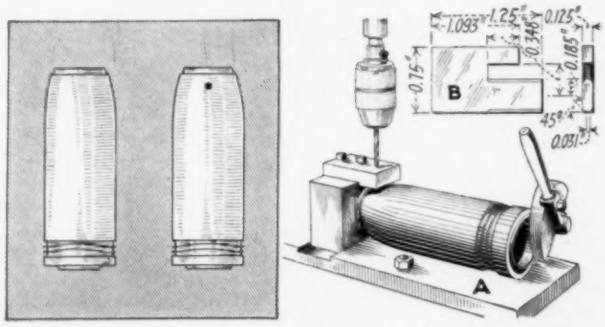
scheduled time for drilling the tapping-size hole for the fixing screw is 50 per hour, but as high as 80 per hour has been done.

The inspection covers the size of the hole and its distance from the nose of the shell. Drilling is day's work plus a bonus. The boys drill all the shells that pass the previous operation.

The eighteenth operation is tapping the ¼-in. fixing-screw hole. It is done on sensitive drilling machines, as shown in Fig. 32. These machines are situated within easy reach of the machines where the hole is drilled. As soon as a shell is drilled, the boy lays it on a table convenient for the boy who does the tapping. The jig, shown in Fig. 33, is similar to the one used for drilling, except that the wedge is dispensed with so that the work is free to float slightly and accommodate itself to the tap. This operation is also handled by boys, and the scheduled output is 80 holes per hour. As in the drilling operation, the tapping must keep pace with the speed of the shop.

The nineteenth operation is hand tapping the fuse hole. The result of hand tapping is twofold—the burr left by the tap in the fixing-screw hole is removed and the thread in the fuse hole is brought to standard size. It will be remembered that the thread in the fuse hole was milled 0.002 in. under size.

The shells are held in cast-iron hinged chucks, similar to the one shown in Figs. 4 and 5, and mounted on stout posts set in the floor of the shop. Adjustable taps are used and give fair satisfaction. In another works the



OPERATION 17. DRILLING FIXING-SCREW HOLE

Machines Used—Sensitive drilling machines.
Special Tools and Fixtures—Drill jig A.
Gages—Distance of fixing screw from top, gage B.
Production—One boy and one machine, 50 per hr.
Note—Drilling compound used.
References—See Figs. 30 and 31.

taps are of the shell type, double ended and solid, as shown in Fig. 34. These taps are threaded without any relief. The flutes are cut with a plain half-round cutter. Sanderson double special steel is used. The taps are held on a shank such as is used for shell reamers. When one end of the tap is worn, the tap is reversed on the holder and the other end used. Solid sizing taps give much more uniform results than are obtainable with the usual run of adjustable taps. Ordinary tap wrenches

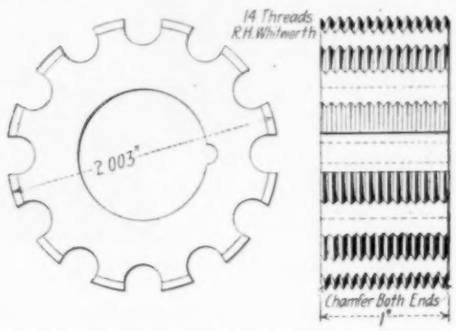


FIG. 34. SOLID DOUBLE-ENDED SHELL TAP FOR FUSE HOLE

are used with either type of taps, and a man can tap about 30 fuse holes per hour.

The inspection on this operation covers the size and condition of the thread and the angle of the fuse seat. The high diameter of the thread is 2.003 and the low diameter 1.997 in.

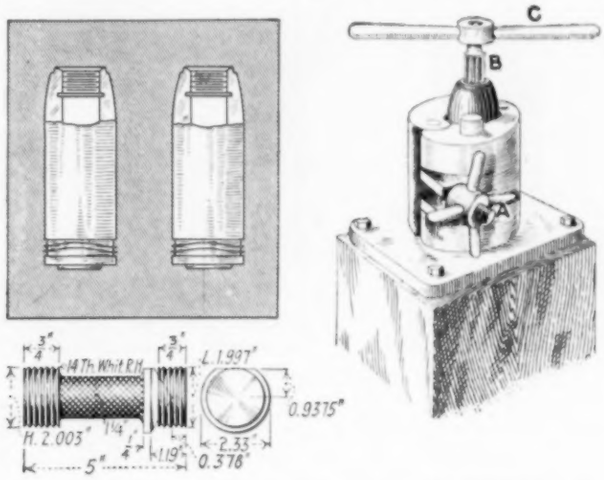
Having passed inspection, the shells are conveyed by the truck gang to the sorting floor to be arranged in series.

The twentieth operation is the selection of shells to make up a series. Formerly a series was made up of 120 shells, and when of this size seven heat numbers were allowed in its make-up. That is to say, a series of 120 shells may contain shells representing seven different heat numbers. The number of shells in a series now is 250, and 15 heat numbers are permitted in its make-up.

In Fig. 35 is shown the sorting floor, laid out in squares, each of which is marked with a *current* heat number. The shells are grouped according to their heat numbers in the squares bearing a similar mark, and the series is made up from these lots, care being exercised that the small series (120 shells) contains not more than seven heat numbers and the large series (250 shells) not more than fifteen heat numbers.

The record so far for sorting shells is: 14 series of 250 shells in 10 hr. by a squad of 8 men.

A series having been selected, the shells are put in tote boxes, as shown behind the marking machine in Fig. 36, and taken by the truck gang to the air-operated marking



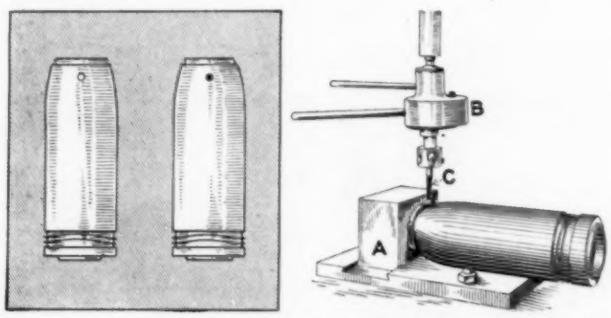
OPERATION 19. HAND TAPPING THE FUSE HOLE TO FINISHED SIZE

Machines Used—None.
Special Tools and Fixtures—Hinged vise A. Adjustable tap B. Tap wrench C.
Gages—High and low plug thread gage D with angular seat gage on one end.
Production—One man, 30 per hr.
References—Figs. 4 and 5 for details of vise. Fig. 34 for sizing tap.

machine to undergo the twenty-first operation, that of marking.

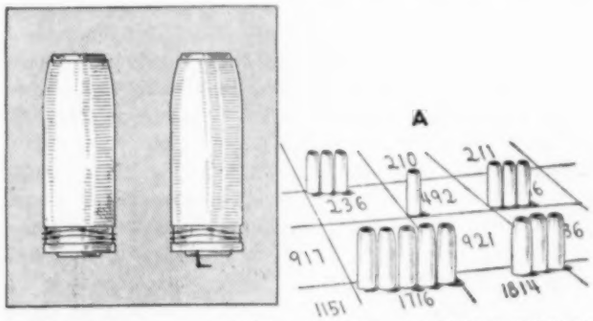
The projectiles for fixed ammunition are always marked on the side. This is somewhat easier to accomplish than marking on the base, which is required with separate ammunition. The shells are laid on their sides on tables and as they are rolled along toward the marking machine three chisel cuts are made across the wave ribs.

The air cylinder *A*, Fig. 36, is about 6 in. in diameter and is supplied with air at 80 lb. pressure per square inch. The forward end of the ram *B* is loosely connected by means of a yoke with the slide *C*. In the center of the slide *C* is a chase to hold the removable hardened-steel type. Certain parts of the imprint (such as the maker's name) on the shells are permanent. That is to say, they do not require to be changed from series to series. Other parts, such as the series letters and the date of manufacture, require to be changed from time to time. The



OPERATION 18. TAPPING THE FIXING-SCREW HOLE

Machines Used—Sensitive drilling machines.
Special Tools and Fixtures—Jig A. Tapping attachment B. ¼-in. tap C.
Gages—None.
Production—One boy and one machine, 80 holes per hr.
Note—Oil used as lubricant.
References—See Figs. 32 and 33.



OPERATION 20. SORTING SHELLS BY HEAT NUMBER

Machines Used—None.
Special Arrangements—Tote boxes and trucks. The floor A is divided into squares marked with current heat numbers as shown.
Gages—None.
Note—14 series of 250 shells in 10 hr. by 8 men.
Reference—See Fig. 35.

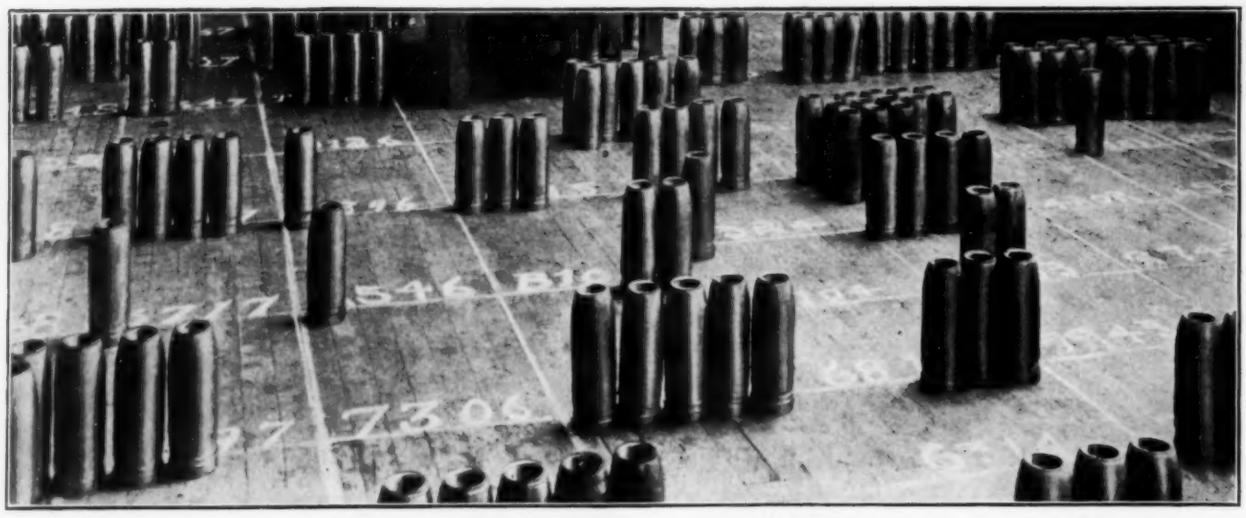


FIG. 35. THE SORTING FLOOR LAID OUT IN SQUARES, ONE FOR EACH HEAT NUMBER

shell to be marked is placed by one operator in the position occupied in the illustration by the shell *D*. When the shell is properly located, the operator signals his assistant, who opens the air valve. The plunger goes forward, and the shell is rolled between the type in the chase and the inner surface of the housing *E*. As there is only a line contact between the type and the shell, the imprint can be made very deep and distinct.

The scheduled output of the marking machine is 125 shells per hour. This represents the speed at which the operators can handle the shells, not the speed of the machine. With the shells arranged so that they are within easy reach of the operator he can mark them at the rate of 20 per minute.

First Complete Shop Inspection and Hospital Work

The twenty-second operation is the first complete shop inspection. It covers all the work done in the various operations up to this point of manufacture. It also includes the discovery and correction, if possible, of all injuries suffered by the shells in their passage through the shop. Having undergone so many operations and handlings, many of the shells are slightly bruised and dented. It is the duty of the shop inspectors to look for such defects and of the "hospital gang" to correct all which can be corrected. The hospital gang works under the direction of the shop inspectors, and among its duties is the removal, by filing in the lathe, of the burrs raised by the type in the marking operation. The removal of these burrs permits the high-diameter ring gage to pass over the shell. The edge of the fuse seat in the nose of the shell is quite sharp and for that reason is likely to be dented by coming in contact with the other shells and hard materials in its way through the shop. These dents are corrected with a rose reamer of the proper shape. After passing shop inspection and the necessary corrections having been made by the hospital gang, the shell bodies are thoroughly cleaned. Exceptional care is taken with this part of the work. All dirt and grease both inside and out, are removed by immersing the shells in hot caustic soda. While thus immersed, they and the soda are agitated. After draining, the work is put through two baths of clean boiling water to remove all traces of soda.

For the preliminary examination, shells with the machined parts finished are presented in lots and inspected for freedom from cracks, flaws, scale, rust and other material defects and for smoothness of surface. The operations enumerated in Table 2 are carried out. The recess in the base of the shell is examined. Shells which

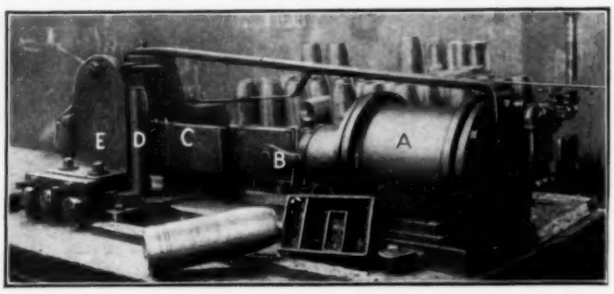
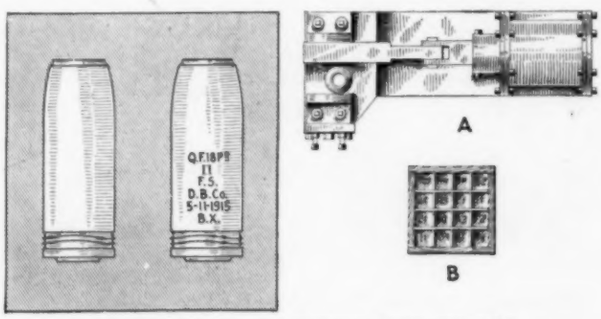


FIG. 36. PNEUMATIC MARKING MACHINE

are to be fitted with the new type of base plate have the recess inspected for both the diameter and flatness of the bottom.

No patching, stopping, plugging or electric welding is allowed. Shells found correct are marked by the inspector with this work mark in the following manner, as illustrated in Fig. 37.

1. A work mark is stamped on the body immediately in front of the driving-band groove to indicate that the driving-band groove is correct and ready for the band.



OPERATION 21. MARKING THE SHELLS

Machines Used—London air marker A
Special appliances—Font of steel type B.
Gages—None.
Production—Two men and one machine, 125 per hr.
Reference—Fig. 36.

2. A second work mark is stamped above the first if the shell is found correct to body gaging and visual examination. (As an alternative these work marks may be placed in the rear of the driving-band groove, the one indicating the correctness of the groove being next to it.)

3. A work mark is stamped on the shoulder to indicate that the threads in the head are correct.

TABLE 2. INSPECTION OF HIGH-EXPLOSIVE SHELLS

Operation No.	Operation	Per Cent. to Be Done on 18-Pounder
1	Examination of fractures and work marks on billets	100
2	Internal and external examination before varnishing	100
3	Undercut in groove for driving band	100
4	Low diameter of groove for driving band high and low	100
5	Examination of threads in base and head	100
6	Concentricity of cavity	100
7	Depth and flatness of recess for base plate	100
8	Examination of base plate before insertion	100
9	Examination of base recess for flaws	100
10	Base calipers	100
11	Wall calipers	50*
12	Diameter of body high and low	100

*When a shop has been turning out satisfactory work for some time, the percentage of shells inspected for wall thickness is only from 10 to 20.

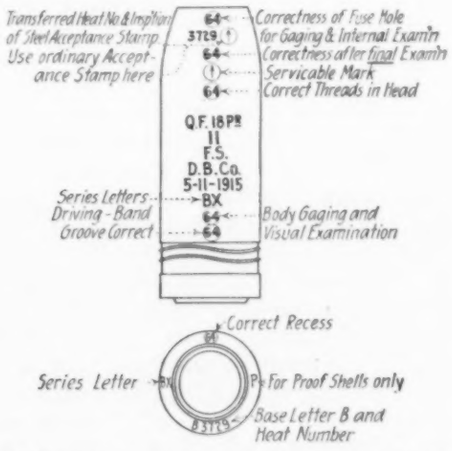
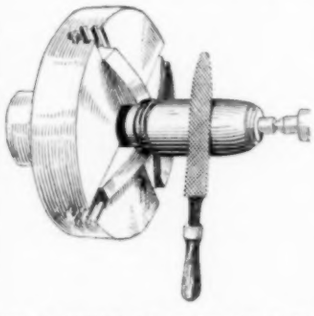


FIG. 37. MARKING CHART FOR GOVERNMENT INSPECTOR

4. A work mark is stamped in the bottom of the base-plate recess and one on the base of the shell near the edge of the recess to indicate the correctness of the recess.

5. A work mark is, in the case of threaded base plates, stamped on the inner face of the base plate to indicate flatness and freedom from flaws.

If the manufacturer desires, the selection of a shell for proof is permitted at this stage, a distinguishing mark *P* and his work mark being put on its base by the inspector. The completion of the shell can now be hastened. When completed it is subjected to the usual final examination and forwarded by the contractor to the Chief Inspector of Arms and Ammunition Cartridge Factory, Cove Fields, Quebec, for proof. The preparation of the shell for proof is done at Quebec.



OPERATION 22. FIRST GENERAL SHOP INSPECTION AND HOSPITAL WORK

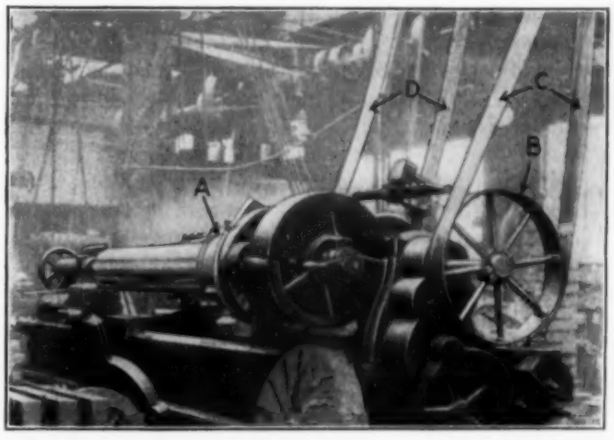
Machines Used—Lathes for filing off marking burrs and reaming noses of damaged shells.
Special Appliances—Tanks for hot caustic soda and for hot water.
Gages—All gages that have been used in the operations which have preceded this operation.
Production—8 inspectors and 4 men in the hospital gang put through 350 shells per hr.
References—None.

Grinding the Columns of Radial Drilling-Machines

By E. A. Thanton

To rough-turn and then grind is an ideal way to finish radial drilling-machine columns. To turn a column in a lathe and then remove it to a cylindrical grinder for finishing is not only a nuisance, but it is impossible to set a heavy column in the grinder in exactly the same position in which it was turned. To obviate this difficulty, the Mueller Machine Tool Co., Cincinnati, Ohio, turns and grinds in the same machine, as shown in the accompanying illustration, which shows the piece chucked in position.

The column is first rough-turned and then a heavy electric grinder is used on the cross-slide to grind with, as shown at *A*. The grinding wheel runs down as usual,



GRINDING A RADIAL DRILLING-MACHINE COLUMN ON THE LATHE

so the column must be made to revolve in the opposite direction from that used in turning. This is done by placing a pulley at *B*, which is run by means of a cross-belt *C* from a small pulley on the countershaft above. While this is being used, the regular cone drive-belt *D* is simply allowed to hang loose on the cone. The grinding drive is direct, as the pulley shaft is pressed into the rear end of the lathe spindle, and the pulley *B* mounted upon it is shown.

The column shown is 11 in. in diameter and 9 ft. overall, with a length to be ground of 7½ ft. In grinding, the column revolves about 25 r.p.m., and a 12-in. wheel is used on the electric grinder. A pan of water is set on the cross-slide directly under the grinding wheel and catches all the abrasive and grinding chips as they are thrown downward by the wheel, keeping the lathe ways and other parts free from grit.

The entire rig is simple in design, construction and application and is a good example of the adaptation of a regular plain machine tool to an unusual job which otherwise would require a large expensive machine tool.

Effect of Feed and Diameter on Cutting Speed of Drills

By A. Lewis Jenkins*

SYNOPSIS—A formula for the cutting speed of twist drills is derived from experimental work on other cutting tools, the practical experience of shops that have systematized their drilling practice and proposed tables of feeds and speeds from reliable sources. It combines a constant, the drill diameter and feed, in an expression that equals the speed. An alignment chart gives an easy method for using the relations of the formula.

Through the mass of literature on drills and drilling covering proposed feeds and speeds for different diameters, these two questions come to the top: How much does a given change in the feed of a drill affect the allowable cutting speed? What is the relation between diameter and cutting speed?

These questions were answered by Dr. Frederick W. Taylor for lathe tools, but no definite statements of laws or theories have been proposed for these relations when applied to drills. In an editorial, Vol. 33, page 843, the *American Machinist* very forcibly called attention to the fundamental principles to be considered in drilling, and emphasized the fact that "too little real study is given to it in many shops." Our present knowledge of these laws is more a result of evolution from, than a systematic study of, fundamental principles.

The data on which the proposed equations given in this article are based were taken from the experiences of well-systematized shops, makers of drills, proposed tables of speeds and feeds, and the results of Doctor Taylor's research.

Effect of Diameter on Cutting Speed

Proposed tables for cutting speeds are at variance in regard to the relation between cutting speeds and diameters of drills. Some suggest a constant cutting speed for all diameters when working in cast iron and a lower speed for the larger sizes when cutting steel. Others propose a constant cutting speed for steel and a variable one for cast iron.

This variance may be partly accounted for by the fact that cutting speed depends upon the feed as well as the diameter, and by changing the values of the feeds it is possible to increase or decrease the speed with the diameter or to use a constant cutting speed for all diameters. These laws for lathe tools are exemplified in the tables for Taylor's cutting speeds (see Halsey's handbook), where he gives speeds for various feeds for each depth of cut. By examining these tables or the equations from which they were derived, it is easily seen that a constant cutting speed may be used for any depth of cut by selecting the proper feed.

The breadth of a drill chip is equal to the length of the cutting edge, which is proportional to the diameter of the drill. The cutting edge is a straight line and the thickness of the chip before it is removed is constant throughout its breadth. According to Doctor Taylor the cutting speed V (ft. per min.) for a straight-edge lathe tool cutting a chip of constant thickness from a steel forging is

$$V = \frac{constant}{L^{0.22}} \qquad (1)$$

where L is breadth of chip in inches.

The action and working conditions of a drill in this respect are quite different from those of a lathe tool. Increasing the diameter of a drill increases its ability to conduct the heat away from its point. The differences in lip angles, wear, formation of chips, etc., have the effect of greatly reducing the value of the exponent of L, and the equation may be written

$$V = \frac{constant}{d^{-0.08}} = constant \times d^{0.08} \qquad (2)$$

where d is the diameter of the drill in inches.

According to this equation, the cutting speed increases with the diameter when the feed is constant.

It has been generally observed that for a given drill working in a given material the cutting speed may be increased when the feed is decreased, and *vice versa*. The cutting speeds of small drills are often limited by the spindle speeds of the machines, and the feeds are limited by the strength of the drill or the feeding mechanism. For large drills the maximum allowable feed is usually limited to the stiffness of the work and the machine. It is frequently necessary to use small feeds in order to obtain the required degree of accuracy for holes of considerable depth.

The feed is directly proportional to the thickness of the chip and, according to Doctor Taylor, the relation between cutting speed and thickness of chip for a straight-edged lathe tool, when the chips are of constant breadth, is

$$V = \frac{constant}{T^{\frac{1}{4}}} \qquad (3)$$

for mild steel, and

$$V = \frac{constant}{T^{\frac{3}{8}}} \qquad (4)$$

for hard steel.

In these equations V is the cutting speed in feet per minute and T is the thickness of the chip in inches before it is removed.

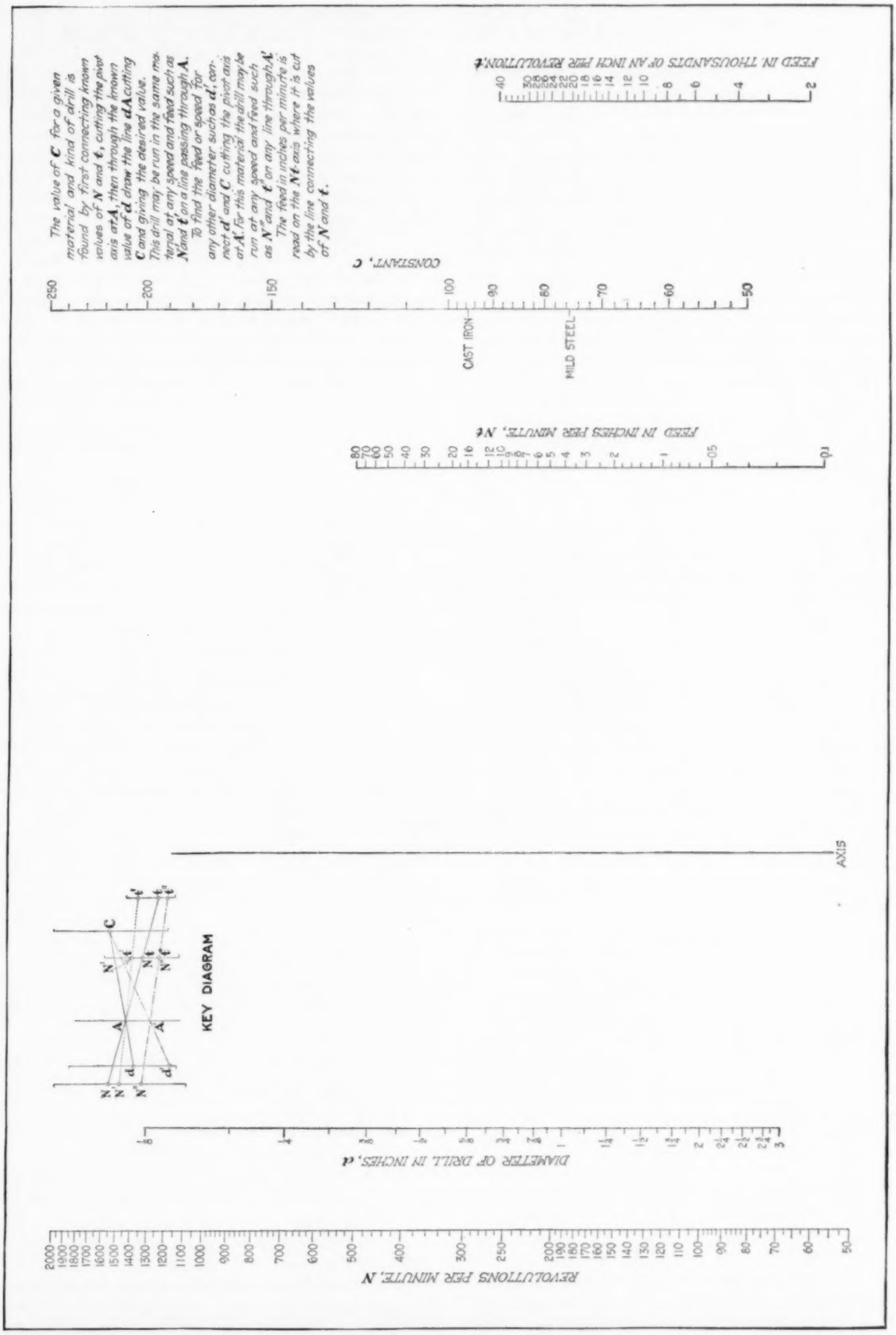
Doctor Taylor's exponential equation for cutting speeds for a ¾-in. round-nosed tool working on cast iron shows that the relation between cutting speed and feed, when the feed is small, may be represented by

$$V = \frac{constant}{F^{0.38}} \qquad (5)$$

where F is the feed per revolution of the round-nosed tool.

The data from which these equations were derived were for lathe tools taking much heavier cuts than used for drilling. For very light feeds or thin chips the cutting action of the tool is somewhat different. The cutting angle of a drill is different from that of a lathe tool, and the latter is not encumbered with the "chisel point."

*Associate professor of mechanical engineering, University of Cincinnati.


The value of C for a given material and kind of drill is found by first connecting known values of N and t, cutting the pivot axis at A, then through the known value of d draw the line dA cutting C and giving the desired value. This drill may be run in the same material at any speed and feed such as N and t on a line passing through A.
To find the feed or speed for any other diameter such as d', connect d' and C cutting the pivot axis at A. For this material the drill may be run at any speed and feed such as N' and t' or any line through A'.
The feed in inches per minute is read on the NV axis where it is cut by the line connecting the values of N and t.
CONSTANT, C
CAST IRON
MILD STEEL
FEED IN THOUSANDTHS OF AN INCH PER REVOLUTION, t
FEED IN INCHES PER MINUTE, Nt
KEY DIAGRAM
AXIS
DIAMETER OF DRILL IN INCHES, d
REVOLUTIONS PER MINUTE, N

ALIGNMENT CHART, SHOWING RELATION BETWEEN FEED, SPEED AND DIAMETER OF TWIST DRILLS—BY A. LEWIS JENKINS

The cutting speed at a point on the edge of a drill varies with the radius, whereas it is practically constant for a lathe tool.

Drills are run at speeds that cause them to fail by "wear of the first class," or by friction without heat, whereas lathe tools fail by "wear of the second class," or friction and heat combined (see "Art of Cutting Metals" Par. 175). Doctor Taylor's equations are based on "wear of the second class," and the laws of governing this condition are different from those for "wear of the first class."

The action of the "chisel point" when a drill is in operation has never been explained, but it probably affects the cutting speed in the same sense as increasing the hardness of the material, which means that it decreases the exponents in the above equations.

The effects of the modifications found by comparing a lathe tool with a drill are not definitely known, and they would be very difficult to find by direct experiment. In view of these considerations and in the light of the discussions of Taylor, Nicolson, Lindner, Herbert and others, the relation between feed and cutting speed for drills cutting cast iron, steel or brass may be expressed with a fair degree of accuracy by the equation

$$V = \frac{constant}{f^{0.24}} \qquad (6)$$

where f is the feed in inches per revolution.

By a careful study of the proposed feeds for drills it was found that the relation used when the cutting speed is constant for all diameters is represented by the formula,

$$f = \frac{d^{\frac{1}{2}}}{K} \qquad (7)$$

where K is a constant depending upon the material drilled, the shape and construction of the drill, and whether it is made of high-speed or carbon steel. There is considerable variation in the values used for K; the values given in the table are an average. This formula (7) has been in use for several years and its adoption has been rather general.

TABLE OF VALUES OF FACTOR K IN FORMULA FOR DRILL FEEDS

Kind of Drill	Cast Iron	Hard Steel	Medium Steel	Soft Steel	Brass
High-speed	80	115	125	140	105
Carbon	64	92	100	112	84

By combining equations (2) and (6) we obtain the following:

$$V = constant \times \frac{d^{0.08}}{f^{0.24}} \qquad (8)$$

This reduces to $V = constant$ where $f = \frac{d^{\frac{1}{2}}}{K}$.

By substituting $\frac{\pi d N}{12}$ for V, we have

$$dN = \frac{\pi}{12}\left(constant \frac{d^{0.08}}{f^{0.24}}\right),$$

or

$$dN = constant \times \frac{d^{0.08}}{f^{0.24}}$$

Substituting C for this constant, the revolutions per minute are expressed by the equation

$$N = \frac{C}{d^{0.92} f^{0.24}} \qquad (9)$$

where C depends on the drill, the work and the feed.

The alignment chart shown on page 153 solves equation (9) and also shows the feed in inches per minute when the revolutions per minute and feed in inches per revolution are known.

The values of C for cast iron and mild steel specified on the chart represent an average performance of ordinary high-speed twist drills driven by a vertical drilling machine. The cutting speed varies greatly with the grade of material, kind of drill and kind of machine used. Tables of cutting speeds for high-speed drills working in cast iron show a range in cutting speed from 45 to 100 ft. per min. and a variation as great as 300 per cent. in the feeds. Hence, for a single material such as cast iron several values of C are required to cover the variations due to high-speed or carbon drills, whether driven by a radial or vertical drilling machine or a turret lathe, depth of hole, coolant and strength and stiffness of the work.

For a given class of work it is necessary to do more or less experimenting in order to find the best feeds and speeds to use, and after these have been determined it is not always possible to get them from the machine. The value of C for a given material may be found by knowing the permissible speed N for a given diameter d and feed f, by drawing a line through the values of N and f on the chart, cutting the "pivot axis" at A and then through d and A drawing a line cutting at C. This value of C may be used for any diameter of drill and permissible feed for the same conditions, such as material and machine. Any line through A cutting the N and f axes, such as $N'f'$, give permissible feeds and speeds for the diameter d. For any other diameter, such as d', connect d' and C, cutting the "pivot axis" at A'. Then any speed and feed, such as N'' and f'', may be used.

By reading the values of Nf, $N'f'$ and $N''f''$, it is easily seen which gives the greatest feed in inches per minute.

Very small feeds may permit the drill to cut intermittently because of the spring of the work or the machine, and too large a feed causes the drill to split or injures the point. The values given by formula (7) and in the table are well within safe limits.

The feed in inches per minute when using a feed per revolution of $f = \frac{d^{\frac{1}{2}}}{K}$ is

$$Nf = \frac{Cd^{\frac{1}{2}}}{Kd^{0.92} f^{0.24}} = \frac{C}{Kd^{0.59}\left(\frac{d^{\frac{1}{2}}}{K}\right)^{0.24}} = \frac{E}{d^{0.67}} \qquad (10)$$

where

$$E = \frac{CK^{0.24}}{K} = \frac{C}{K^{0.76}} = constant$$

This shows that the permissible feed is greater for small than large drills. The cubic inches of metal removed per minute is

$$\frac{Nf\pi d^2}{4} = \frac{E\pi d^2}{4d^{0.67}} = 0.7854 E d^{1.33} \qquad (11)$$

which shows that the volume is increased 2.5 times when the diameter is doubled.

From Dempster Smith's equation for torque the

$$Horsepower = F\, d^{1.8} f^{0.7} N$$

where F is a constant for a given kind of drill and material. The amount of metal removed per horsepower per unit of time is

$$\frac{MNfd^2}{Fd^{1.8} f^{0.7} N} = Hd^{0.2} f^{0.7} = Hd^{0.2}(d^{\frac{1}{2}})^{0.7} = Hd^{0.43} \qquad (12)$$

where M, F and H are constants depending upon the material and kind of drill used. This indicates that a large drill is more efficient for removing metal than a small one.

Three-Inch Russian Shrapnel--II*

By John H. Van Deventer

SYNOPSIS—After coming from the heat-treatment operation and having their base ends formed to finished size, the shells are carried through a number of operations which bring them to the point where the balls, smoke powder and rosin are inserted. This article follows the process up to and including the operation in which the copper band is pressed into the band groove.

The contingent account of a shell manufacturer must contain many items, among which that of defective and rejected shells has an important place. It is impossible to tell in advance how many shells will prove defective; but conservative practice is to make the allowance for this not less than 10 per cent. of the entire product. Shop defectives and rejections in the plant that I am describing run way under this amount, and yet the original estimate of defectives of 20 per cent. is still maintained. This discrepancy between the estimated loss and what actually occurs is simply an example of conservative contingent-fund practice. While it has fortunately not yet happened that a batch of finished shells from this plant has been rejected at the Canadian proving ground, there is always the possibility of this happening, and the expense of having 5,000 shells rejected at one blow would go a long way toward drawing off some of the surplus of the contingent fund. If a thing of this kind should not happen and the low percentage of shop loss should not be augmented by a rejected batch, it is an easy matter eventually to transfer the balance of unused contingency surplus into the profit account.

While on this subject, it will be of interest to point out some of the requirements that govern the acceptance of finished shells at the proving ground, since it will qualify the reader's judgment of the necessary care and attention given to each of the operations described.

Factory inspection by no means determines the final acceptability of the shells. This final decision is made under what is known as a controlling test, in which test specimens are actually fired from guns. For each batch of 5,000 shells which have passed the Government inspector located at the factory, a selection of 10 shells is made for a tensile test. Three flat longitudinal strips are cut from a cylindrical part of the shell, parallel to its axis, immediately above the band groove. The test requirements are a breaking strength not under 8,000 atmospheres (117,600 lb. to the square inch) and a final lengthening distention not less than 8 per cent.

In addition to these 10 shells which are tested for tensile strength, 50 projectiles from each batch are given a firing test. After being fired without explosive charges in the shell itself, the projectiles are gathered and tested by exploding them in a pit, those shells being used which have received no damage during the firing test. Ten of these shells are thus tested by exploding. An idea of the strictness of the controlling-batch test may be gathered by the following requirements: No breakage must occur in the bore or in front of the muzzle of the gun during firing. There must be no separation of the head from the case of the shrapnel in the bore or in front of the muzzle of the gun. No traces of the rifling must be apparent on the cylindrical part of the butt of the projectile picked up after firing, although weak traces of the rifling on the bourrelet, extending over not more than one-half the circumference, are not considered causes for the rejection of the batch.

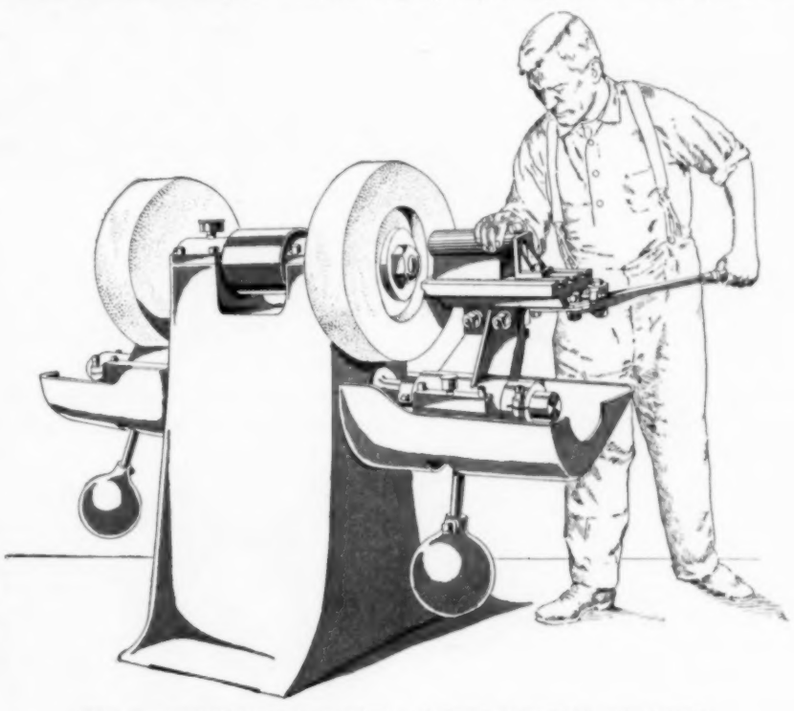


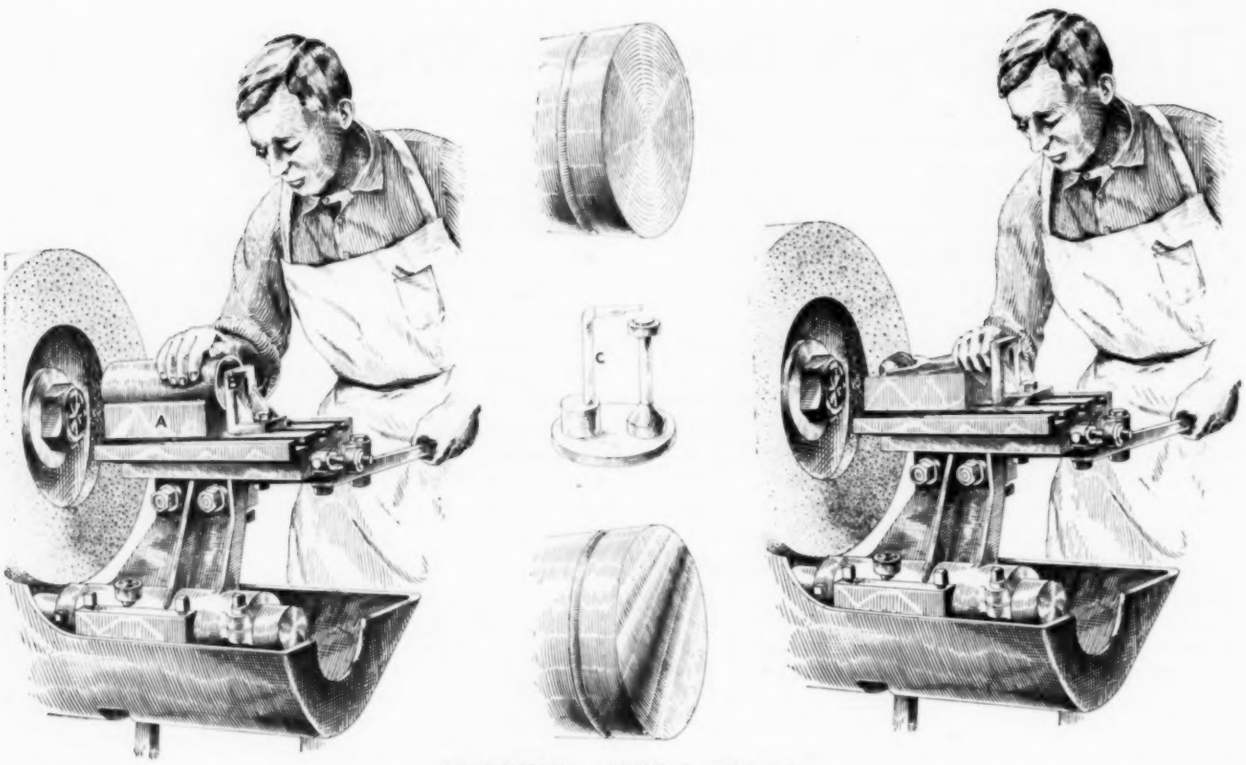
FIG. 5. GRINDING BASE END OF THE RUSSIAN SHRAPNEL

There must be no curving of the base of the shell, nor an increase of the diameter of its cylindrical part, in excess of one point. Among the shells that are given a firing test there must not be over 20 per cent. in which the upper end of the powder tube has issued from the socket of the copper plug. In addition to this there must be no considerable crimping of the central tubes, cracks on these tubes or a penetration of the tubes themselves into the powder chamber.

In the explosion test there must be no tearing off of the bases of the shell, and the bodies of the cases must remain entire in at least 70 per cent. of those tested.

As far as the copper drive bands are concerned, there must be no tearing off or displacement of these during the firing test, and the rifling marks left upon them must have a regular appearance and not be broadened.

*Previous installment appeared on page 89. Copyright, 1916, Hill Publishing Co.



OPERATION 8. GRIND BASE END

Machine Used—Gardner No. 4 double-disk grinder.
Special Fixtures and Tools—Regular equipment used. Vee-block for shell A, length stop B.
Gages—Straight-edge to test base for flatness. Swing gage to test for thickness of base C.
Production—One machine with two operators can grind the bases of 250 shells per hr.
Note—This operation is performed both dry and wet. The use of a coolant is not necessary, as the amount of metal removed is only one or two thousandths of an inch. The heat-lot number is replaced on the shell base after grinding. This operation and the following operations are often reversed in sequence to suit shop conditions.
Reference—See Fig. 5.

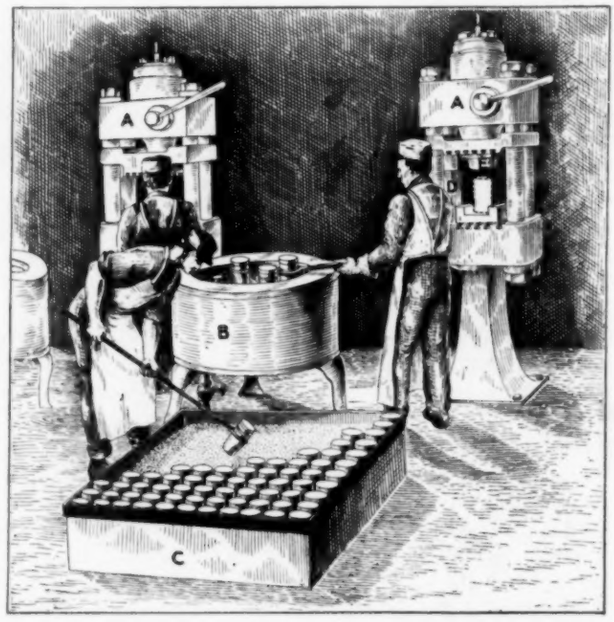
If any shell during the firing test breaks in the bore of the gun or in front of the muzzle, the entire batch of 5,000 shells is at once unconditionally rejected.

The failure of a test batch to meet some of these requirements does not necessarily mean the immediate rejection of the entire lot. The manufacturer is permitted to present more test shells at his own expense; but if these do not prove satisfactory, the chances are that he will find 5,000 unusable shells left on his hands.

These strict requirements may explain why manufacturers who anticipate a factory defective loss of from 2½ to 5 per cent. allow as much as 20 per cent. for a rejection contingency.

One of the noticeable features of the Russian shell is its highly polished base. This finish is secured in the eighth operation by means of a Gardner No. 4 double-disk grinder. Two operators work on this machine, one at each disk, the shell being merely held in a V-block on the swing table and secured by the operator's left hand, his right being used to traverse the shell across the surface of the disk. No lubrication is needed to take care of the light cut, which amounts to but 0.001 or 0.002 in. at the most.

In the illustration accompanying this operation sheet, the method of truing up the special abrasive wheel is shown at the right. Special abrasive wheels are shown mounted on this disk grinder, but the ordinary type of grinding disk is also used with good success and in fact seems to be preferred by the operators. This operation definitely determines the thickness of the base of the shell. A careful gaging follows it, the apparatus shown at *C* being used for this purpose. The shell is placed over the vertical spindle with its powder pocket resting upon the spindle enlargement; and the surface gage, shown at the left, which has plus and minus ground measuring surfaces, is passed over the base of the shell.



OPERATION 9. BOTTLING AND ANNEALING

Machines Used—Watson-Stillman hydraulic punching press A, Frankfort crude-oil fired lead pot B, galvanized-iron annealing trays C.
Special Fixtures and Tools—Distance stops D, heading die E, locating piece F.
Gages—None.
Production—Two men, with one lead pot and one press, head and anneal 240 shells per hr.
Note—Flake mica used for annealing.
Reference—See Fig. 6.

Bottling and annealing are combined in the ninth operation. The perspective illustration accompanying this operation sheet shows another example of nicely timed handwork. Two men are kept busy at each pot, one of them working from the pot to the machine and back to the pot again, while the other works from the pile of shells on the floor to the melting pot and from the melting pot back to the annealing trays of flake mica. The die used on the heading press is not water-cooled, yet does its work without causing the shells to stick.

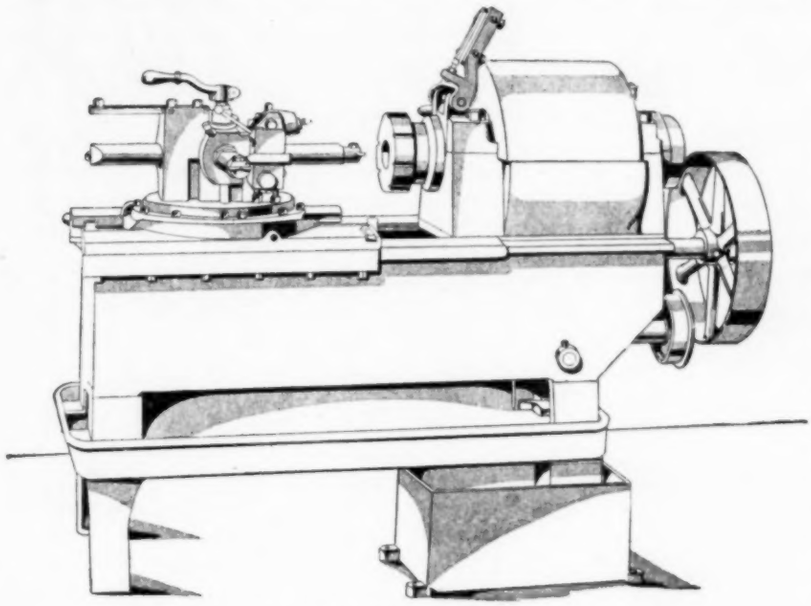
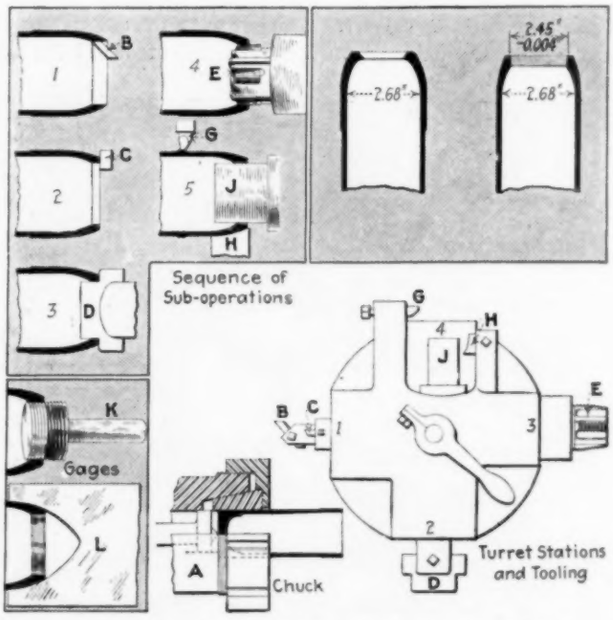


FIG. 6. REAR VIEW OF SPECIAL CHUCKING LATHE



OPERATION 10. BORE, FACE, TURN AND TAP NOSE

Machines Used—Special-purpose chucking lathes.
Special Fixtures and Tools—Special shell chuck A. Cutting tools: 1—Tool for rough-boring thread seat B, rough-facing tool C. 2—Finish cutter D for thread seat and facing end. 3—Collapsing tap E. 4—Turning and forming tools G and H, roller rest J.
Gages—Thread gage K, go and not go; templet for profile L.
Production—From one man and one machine, 18 per hr.
Note—Soap-water lubrication used. The third and fourth suboperations may be reversed in sequence if desired. The form of Whitworth thread prevents injury to threads in nose by the roller rest in the sequence as shown.
Reference—Special-purpose chucking lathe, shown in Fig. 1.

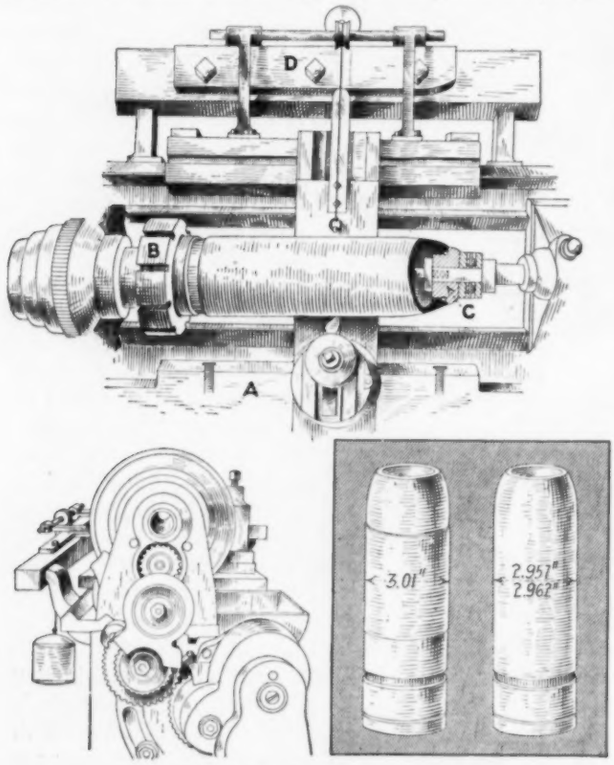
The operation of bottling and annealing is often reversed in order with respect to that of grinding the shell base, this depending upon shop conditions. It makes no difference whether bottling precedes or follows the grinding operation. The rough stock that has been left upon the body and bourrelet of the shell is removed in the eleventh operation. Each man who does this finishing work runs two engine lathes of simple but rigid construction, which are equipped with form-turning templets corresponding to the contour of the Russian shell. From each lathe the operator gets 10 shells an hour, or a total of 20 per hour per man per two machines. This is remarkably fast production, considering the fact that the material is heat-treated nickel steel. Fast cutting must be done to obtain this result; as a matter of fact the cutting speed is over 118 ft. per minute, and the lineal feed is 3 in. per minute. The finish-turning operations leave approximately 0.002 in. for the succeeding filing and polishing operations. A clever tail-end centering device is used on these lathes. It incorporates in its design a plug that fits the finished end of the shell nose and a ball thrust bearing that removes friction which would otherwise result in heating at this high speed. This same centering device is also used on the tailstock of the speed lathe in the following operation. This ball thrust bearing saves considerable power and loss of time, both of which are items worth putting on the right side of the profit ledger.

It has already been stated that the finish equivalent of British shells would be considered entirely too rough for Russian standards, and this fact is impressed strongly upon one who watches the operation of file-finishing and polishing the body. It is hard to realize why the body of the shell, which does not come in contact with the bore or rifling of the field gun, must be subject to such a fine degree of finish; but it must be admitted that the appearance is far superior to that of shells in which the tool marks are permitted to remain. Possibly this fine appearance exerts its influence over those who handle and use these shells, making them unconsciously more careful in their use of the shells. It is hard to imagine any other reason for the insistence on this fine body finish.

The speed lathes used in this operation are examples of effective simplicity. They are mounted upon wooden beds and driven from below through belts tightened with idler pulleys. Brakes are provided to bring the head spindles to a quick stop. The tail spindles of these lathes are actuated by springs, so that all that it is necessary for the operator to do is to release the lever handle, whereupon the ball-bearing centering plug forces the shell into the taper cup chuck, where it is held and driven by friction. This filing and polishing are confined to the body and bourrelet of the shell and do not extend to the nose, which will receive attention after the fuse-socket plug has been inserted and the screws put in.

In tracing the work through the factory, one must at this point leave the shell shop and return to the disk and powder tubes. Unlike that of the British shell of

corresponding size, the powder tube of the Russian shrapnel is not threaded upon the disk end, but is held into the disk by expanding the sides of the tube, which are thinned down at one end for this purpose. There are a number of distinct hand operations required in preparing the disk and tube for insertion in the shell, all of which are shown in operation sheet 13. The illustrations show these steps so clearly that it will be unnecessary to describe any of these suboperations, except the one which has to do with the actual expanding and riveting of the tube. The apparatus used here is extremely simple, consisting of a cast-iron hammering block, a special punch to protect the upper end of the tube, and a hammer. A steel pin the size of the hole in the outer tube is fixed in the hammering block at *B*. At *D* will be noticed two conical stubs. These are expanding plugs. They are used for opening up the end of the tube which is to be inserted. One plug is a little larger than the other and is used when the tubes run undersize. A small drilled hole in the hammering block holds a wad of waste saturated with red lead.



OPERATION 11. FINISH-TURN BODY

Machines Used—Special 16-in. engine lathes fitted with form templets for guiding crossfeed travel A.
Special Fixtures and Tools—Special split collet chuck B, special ball-bearing thrust tailstock plug C, feed templet D.
Gages—Limit snap gages for roughing and finishing.
Production—One operator running two lathes finishes 20 shells per hr.
Note—No lubrication. Cutting speed, 118 ft. per min. Feed per min., 3 in.

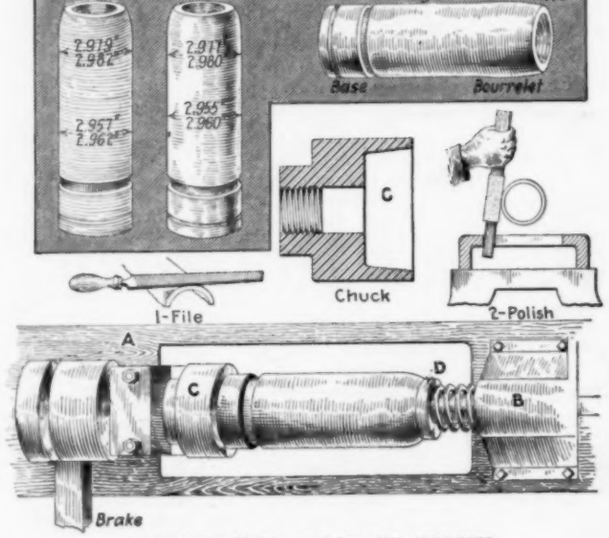
To show the actions making up this suboperation in sequence more clearly, the steps have been laid out in a straight line, beginning with the dropping of the disk over the steel pin, followed by the expanding of the tube, the dipping of the expanded end into red lead and the final riveting of the tube into the disk. The simplicity of the ways and means employed enables this operation to be performed at a remarkably high speed.

The inspection of disks and outer tubes, shown as suboperations 2 and 3, while it has been combined as a part of operation 13, can be dispensed with provided these pieces are otherwise inspected upon receipt. All of the material entering into the shell is furnished to the subcontractor, but unfortunately the degree of inspection exercised at the supplying factories is not sufficiently rigid for it to be neglected and for the goods to be accepted as received. Considerable variation is found in these parts, and especially so in the thread sizes of the fuse sockets and copper fuse plugs.

Coating the edge of the disk with red lead, as shown at 8, is done just previously to inserting the completed disk and tube in the shell, but not before the paint on the exterior of the disk and on the interior of the tube has become thoroughly dried.

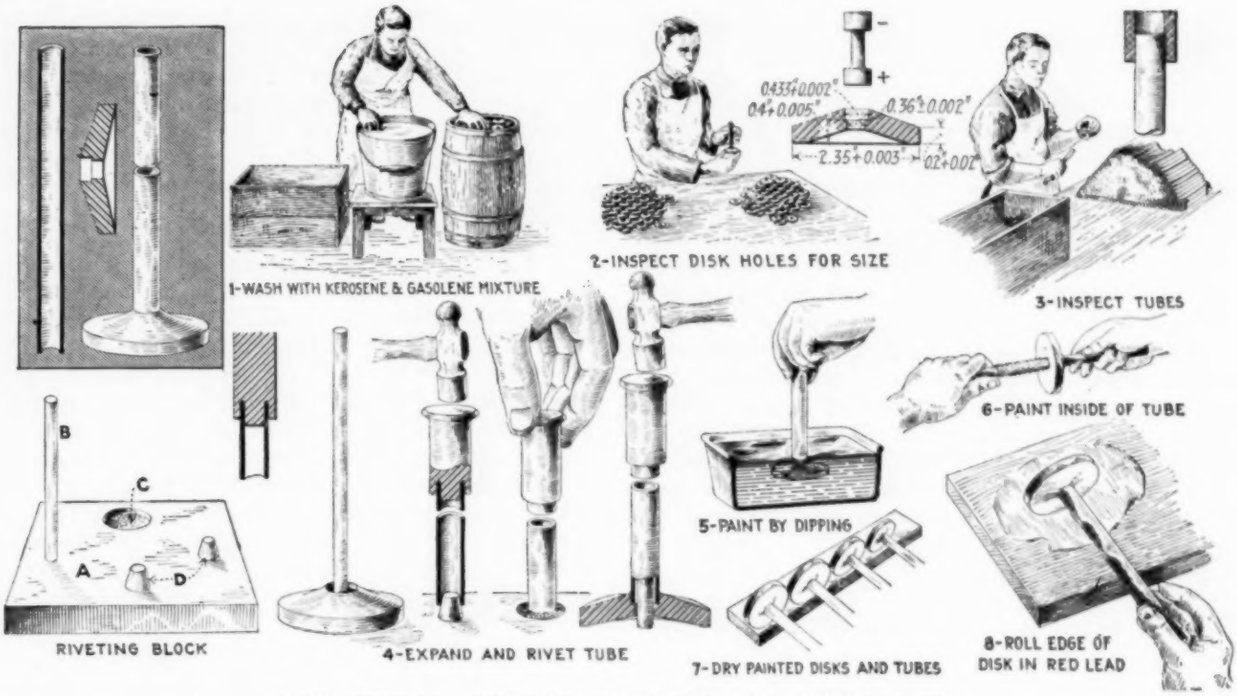
While the preparation of the outer tube and disk has been in progress, the shell itself has been thoroughly washed, cleaned and delivered to the Government inspectors. In this first official inspection it receives practically the same tests as those described in volume 42, page 499, for the British 18-pounder. Particular stress is laid upon the inspection of the interior of the shell at this point, for it is the last opportunity for the Government inspectors to examine this part of the shell, unless they take the completed shrapnel apart or saw it in half. Cracks, scratches, scale, or hair lines on the interior or outside surfaces of the shell are carefully watched for during this inspection.

The painting of the interior of the shell becomes simply a matter of arranging the handling in order to get as high an output as desired from the apparatus shown in operation 14. The machine used is a compressed-air shell-painting machine made by the Spray Engineering Co., of Boston. Pressing the inverted shell over the discharge tube of this apparatus causes it to inject a measured quantity of paint, which is forced up into the powder pocket by compressed air. The air is delivered in such a way that the paint is uniformly distributed and drops



OPERATION 12. FILE AND POLISH

Machines Used—Special polishing lathes A, with spring-actuated tailstock spindles B.
Special Fixtures and Tools—Cup chuck C for base end of shell; ball-bearing tail center D, same as used on body-finishing lathes in operation 11.
Gages—Limit snap gages for bourrelet and body. Body limits, 2.955 to 2.960 in. Bourrelet limits, 2.977 to 2.980 in.
Production—From one machine and one operator, 20 per hr.
Note—Body and bourrelet are both filed and then polished with emery cloth, from $^{1}/_{1000}$ to $^{2}/_{1000}$ in. having been left for this operation.

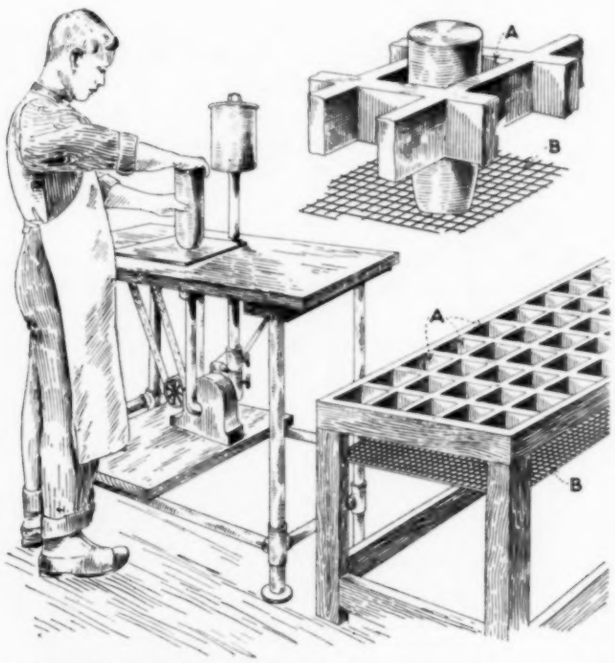


OPERATION 13. PREPARE DIAPHRAGM AND CENTRAL TUBE

Machines Used—Hand operations.
Special Fixtures and Tools—For suboperation 4, a special cast-iron expanding and riveting block D.
Gages—For suboperation 2, a go and not go plug gage A. For suboperation 3, a ring gage B.
Production—No definite rate can be put on this or the succeeding hand operation No. 16. One man and two boys easily handle both operations for 2,500 shells per 10 hours.
Note—The red lead is applied just previous to operation 15 and after the asphaltum paint has dried.

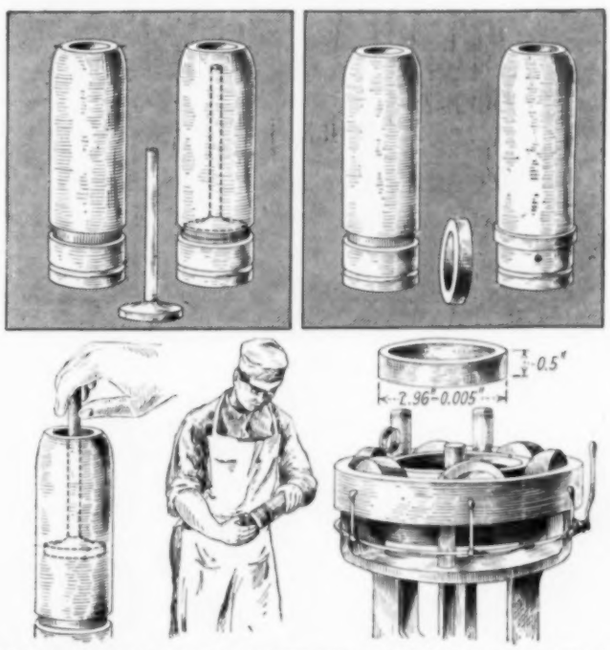
are prevented from running down and gumming up the finished thread surfaces.

One of the conveniences designed to facilitate the handling of shells during the painting operation is shown in this operation sheet. It is a drying rack mounted on wheels, and it may be readily pushed back and forth to bring it into convenient location with respect to the



OPERATION 14. BLOW OUT AND PAINT INSIDE OF SHELL

Machines Used—Spray Engineering Co.'s compressed-air shell-painting machine A.
Special Fixtures and Tools—Portable drying racks B.
Gages—None.
Production—One machine will coat the interior of 250 to 400 shells per hour, depending on the method of handling.



OPERATION 15. PUT ASSEMBLED DIAPHRAGM AND TUBE IN SHELL

Machines Used—Hand operation.
Special Fixtures and Tools—None.
Gages—None.
Production—Included in operation 14.
Note—The assembled diaphragm and tubes are simply dropped in by hand. They must fit loosely, and tight ones are rejected. The succeeding operation, crimping the drive band, must not cause the shell to pinch the diaphragm, and this acts as a check on the distortion of shell wall due to crimping.

OPERATION 16. SET OR CRIMP DRIVE BAND

Machines Used—West hydraulic band-crimping machine A, 6 plungers 6 in. in diameter, operated from accumulator.
Special Fixtures and Tools—None.
Gages—None. The test for crimping is made by tapping the band with a light hammer.
Production—One machine and one operator produce from 30 to 40 pieces per hour.
Note—A maximum unit pressure of 1,000 lb. per square inch is required.

painting machine. The shells rest upon heavy wire netting, which permits free circulation of air to their interiors and helps to dry them quickly.

In the Russian shell, any disks which fit tightly into the disk seats are at once rejected. The disk must be a loose, easy fit and must readily drop into its place. It is inserted before the shell goes to the band-crimping machine and serves as a check upon this operation, for upon coming from this machine the disks must still be free within the shell. Any distortion of the metal due to compression would of course be noticed by a binding of the disk, and this arrangement is made to serve as a convenient gage upon an operation which would otherwise be rather difficult to check up. An additional reason for this free fit is to insure that the disk and outer tube will be readily discharged from the exploded shell and thus serve to back up and give impetus to the discharge of its content of lead balls, acting in this way something like the wad back of the charge of shot in a shotgun shell.

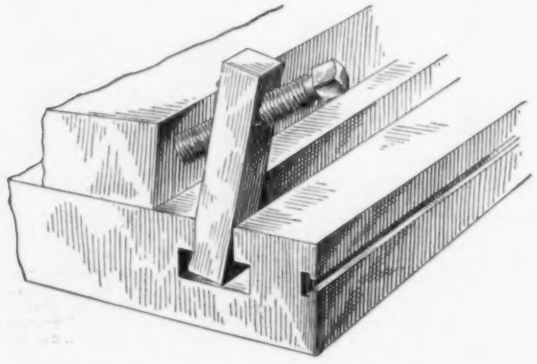
Considerable attention is given to the inspection of the copper drive band. The metal must be of such a character than it may be folded upon itself and may be then flattened with a hammer without signs of breaking. It must be capable of being forged in a cold state until reduced to one-half of its thickness, without giving indications of tearing. The correct seating of the copper band in the band groove of the shell is determined after the crimping operation by tapping the band with a hammer and noticing the clearness of the ring. In addition to this the inspector has the privilege of removing rings from 1 per cent. of the total number of projectiles for the purpose of seeing that they are properly seated. Under the present conditions and large batches, this test is restricted to a much smaller percentage of shells, but is carried out faithfully on the lesser quantities.

(To be continued)

Handy Planer or Shaper Clamp

By H. H. McCray

The planer or shaper clamp shown in the illustration is as dependable and convenient as any I have ever seen. The body is of cold-rolled steel, with the hole for the cup-pointed setscrew tapped through at an angle of 35 to 40 deg. The lower end is notched to fit the edge of the T-slot. The clamp may be withdrawn from the slot after one or two back turns of the setscrew, the head of which is always accessible.



PLANER OR SHAPER CLAMP IN USE

For planing almost any class of work, even comparatively thin pieces, it is surprising how heavy a cut such clamps will hold if a thrust pin is also provided. In a set of four or six the clamps should not cost over 25c. apiece. They will pay for themselves in a very short time.

Methods of Quenching Steel

At a recent meeting of the Huddersfield Engineering Society, S. N. Brayshaw lectured on the quenching of steel. The lecturer first of all discussed the properties which determined the value of any liquid as a quenching medium, and pointed out that the main items of consideration in this direction are specific gravity, specific heat, boiling point, conductivity and fluidity, and gave some interesting information in connection with experiments which he had carried out in the hardening of tools in various ways and by means of various quenchers.

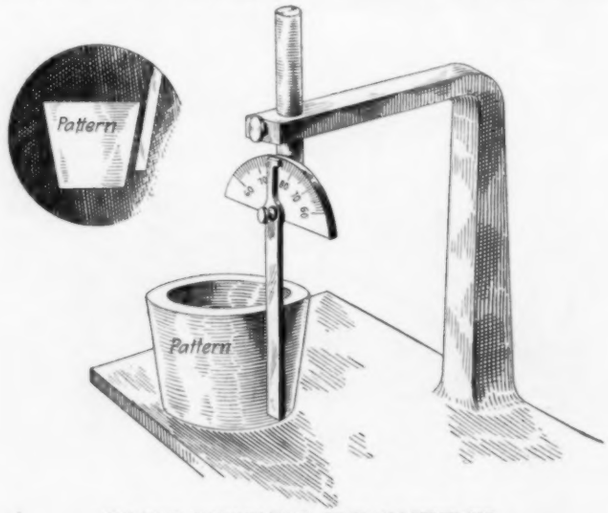
He described the effects of stirring the quenching medium, and also the use of jets for throwing a strong stream against the articles to be cooled. He referred to the use of brine and freezing mixture of snow and salt. He pointed out that the age of water has a great deal to do with its quenching powers and instanced the carrying away of water in barrels from the River Don, in Sheffield, even as far as the United States for this purpose, owing to some peculiar property which it possesses.

The uses of oil, mercury, fusible oils and fusible salts as quenching media were next dealt with, and the lecturer laid down as the ideal medium for quenching, one which is from fluid at 100 deg. C., at a high boiling point of practically 800 deg. C., fairly high specific gravity and of fairly good specific heat. This will give a glass-like hardness to the tools, but the quenching should be carried out at such a temperature that the heat left will prevent breakage.

Draft Indicator for Patterns

By A. E. Holaday

The illustration shows a device which I have found very useful in showing the amount of draft on small patterns. Having the indicator at the end of a long overhanging arm makes it easy to use on a great variety of patterns.

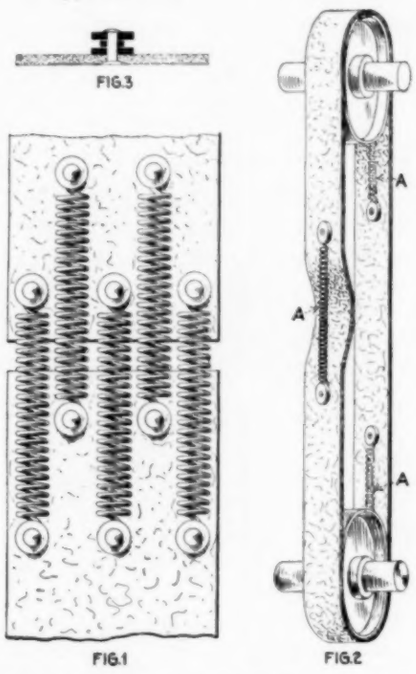


DRAFT INDICATOR FOR PATTERNS

Letters from Practical Men

Keeping Uniform Belt Tension by Use of Springs

Having had considerable trouble with a short 5-in. belt located in an exposed position, I first joined the ends with five short coil springs, as shown in Fig. 1. A smooth running joint was made, but I noticed that when pulling hard, the belt would slip when the springs were on the tight side but pull well when they were on the slack side.



MAINTAINING UNIFORM BELT TENSION

This suggested that by limiting the stretch of the springs and arranging them so that there would always be a spring on the slack side, the belt would drive well with only a few pounds' tension. Three pairs of light springs *AAA* were fastened to the endless belt as shown in Fig. 2. In operation a loop *B* (shown somewhat exaggerated) would form on the slack side. This loop when arriving at the driven pulley would transfer the "take-up" to the springs following, thus making the belt on the tight side travel with a uniform speed.

Fig. 3 shows a sectional view of the fastener used to hook the springs on. It can be made out of a rivet and three washers, and conceals the hooks so that it is safe to handle the belt with the hands. E. E. Larson.

Thompson, Iowa.

Punch Press Used as a Miller

The small shop making a variety of products often gets a job that is a difficult proposition on account of not having the proper tools with which to handle it. Recently a rush order for some fixtures that required a $\frac{3}{8}$-in. square bar, Fig. 1, formed at right angles $1\frac{1}{2}$ in. from one end, with the end turned down to a $\frac{3}{16}$-in. round shoulder, $\frac{3}{16}$ in. long, and with 47 teeth cut 0.100 × 0.100 in. along the flat side, furnished such a problem.

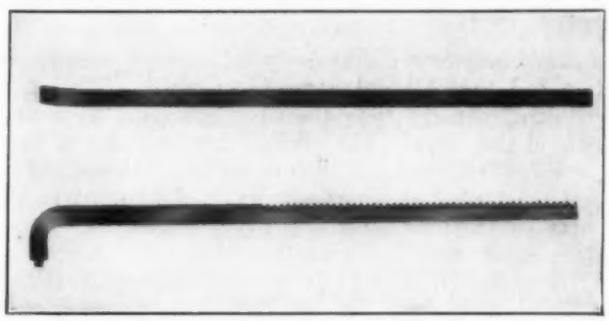


FIG. 1. THE FINISHED ARTICLE

To turn down the end in a screw machine, a special square collet was necessary; so one was turned up the

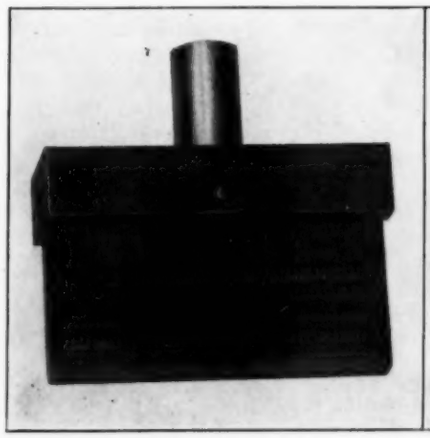


FIG. 2. PUNCH AND HOLDER

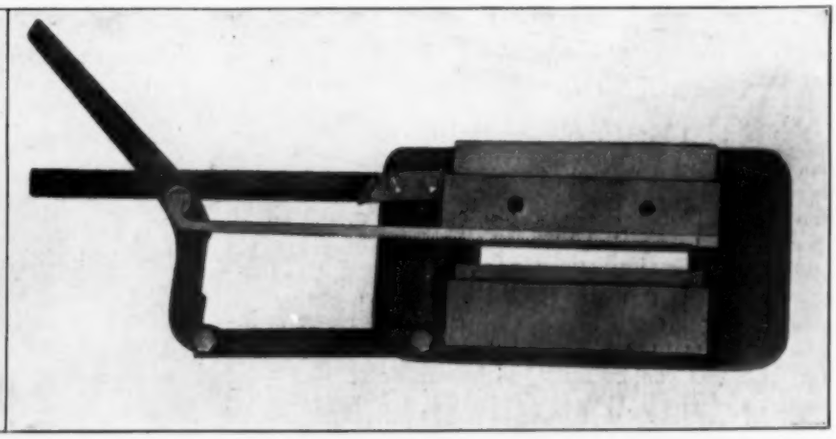


FIG. 3. DIE WITH STRIPPER REMOVED

proper outside dimensions, and the slots were cut with a hacksaw. The square hole through the center was produced by making a small broach from ⅜-in. square tool steel, driving it through by hand and filing to size.

The right-angle forming was done with an ordinary V-die in a punch press, using a round punch. The stock was somewhat distorted, however, so that it was necessary to smooth off the pieces on a grinder.

To cut the teeth, a punch and die, Figs. 2 and 3, were made with teeth exactly the size of the finished cut, the teeth on the punch being about 2½ in. long. The punch was then taken to the milling machine, where four horizontal cuts, ½ in. apart, were made to a depth of about $\frac{1}{16}$ in. beyond the bottom of the teeth. This gave five different rows of cutting teeth. The bottom row was then cut down to within 0.02 in. of the bottom of the teeth. The row above it was cut down to 0.04 in. of the bottom; the one above that, 0.06 in.; the next, 0.08 in., while the last was left full size.

The result was that when put in operation each row of teeth cut off 0.02 in. until the last row, being full size, completed the cut.

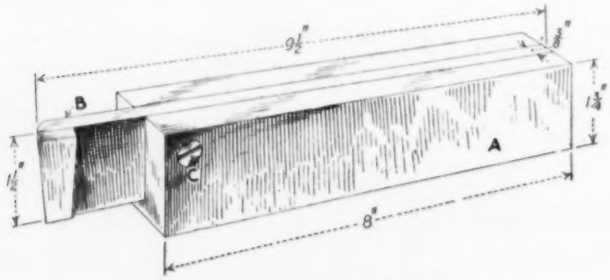
The punch had a pilot sufficiently long to engage in a slot in the die at all times, to prevent the punch from backing away when it struck the work. The die also had a heavy backing to hold the work to the punch, and a thick stripper to prevent the work from turning and binding on the return stroke. The work was slid into place endwise, a toggle lever being used for the purpose.

In operation the die was very satisfactory, except that care had to be taken to provide a stream lubrication sufficient to carry away the chips from the horizontal slots in the punch. The original intention was to have the chips fall away, the slots in the punch being cut so that the teeth had square corners on the bottom and a curve on the top, for this purpose; but as they sometimes stuck, the stream was provided.

Rochester, N. Y. GEORGE AVERY.

Convenient L-Tool Holder

The illustration shows a convertible L- or T-slot tool holder for lathe or planer use. In many shops we find steel used for tools that is double the size of the L- or T-slot, necessitating an added amount of labor in forging and a corresponding loss or waste of steel. When a ⅝-in.



A CONVENIENT TOOL HOLDER

L-tool is required, the blacksmith or tool dresser is instructed to use a piece of a ⅝x1⅝-in. bar of steel, whereas the same tool can be made, as shown, from ⅜x1½-in. steel.

Tool holder *A* can be made of either cold-rolled steel or something better; the cold-rolled is, however, good enough. The piece should be approximately 1¾x1½x8 in. for T-slots ranging from ⅝ to ¾ in. neat. The length of the holder of course varies with the length of the tool block. When used on a lathe, it can be considerably shorter. The piece *A* should be slotted ⅜x$1\frac{5}{16}$ in. deep to admit the ⅜x1½ tool *B*. This can be used equally well for ⅝, $\frac{11}{16}$ or ¾ L- or T-slotting tools, and right- or left-hand tools can be used in the same holder.

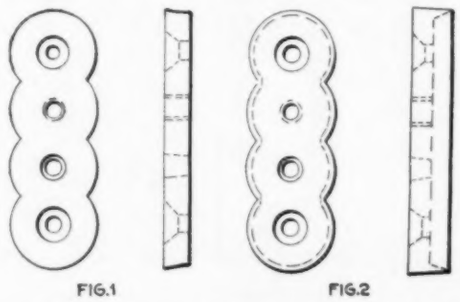
The headless setscrew *C* can be either ¼ in. or $\frac{5}{16}$ in. This screw is located well toward the top, at the end of the holder nearest the cutting point. The slotting tool is made of ⅜x1½-in. tool steel 9½ in. long, the tool being 1½ in longer than the holder and $\frac{3}{16}$ in. higher than the depth of the slot in the holder. It is provided with about 15 deg. rake, and ground with about 7-deg. clearances on all sides. Much less time is taken in dressing these tools than is needed for solid tools.

Covington, Ky. F. A. CALDEHOFF.

An Improved Rapping Plate

Fig. 1 shows the ordinary form of pattern rapping plate which is attached by two flat-head wood screws after the pattern has four holes countersunk in the parting line. If the pattern is in constant use, these screws work loose and the wood splits out along the edges of the plate.

Fig. 2 shows a form of rapping plate that will last about three times as long before needing replacement or change



COMMON AND IMPROVED FORM OF RAPPING PLATE

of position. The lower edge is extended to a knife-edged corner on the periphery about $\frac{3}{16}$ in. in height. The plate is located in the usual manner except that it is driven down into the wood the depth of the knife edge and is then drawn down by the two wood screws. This gives about double the surface to resist rapping as well as acting as a lock on the wood screws, the advantages of which are self-evident. H. B. MCCRAY.

Charles City, Iowa.

Drawing and Punching Die

The illustrations show a method of making in two operations the shell shown at *A*.

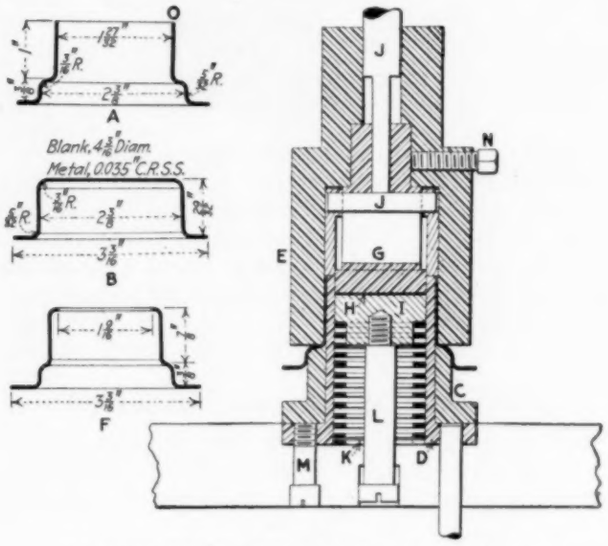
The first operation *B* is made in a regular combination die, which needs no explanation. The shell *B* is made from a blank $4\frac{3}{16}$ in. in diameter, the metal being 0.035 in. thick, of cold-rolled strip steel.

The principle of the die is also illustrated. It is of recent construction and does not seem to be generally known. The die works as follows:

Ring *C* is under rubber pressure just as any combination die would be, and when the press goes back to its proper

stroke, or the full height of the press, the ring *C* comes up level with the top of the cutting edge *D*.

Shell *B* is placed upon *C*, which fits around the outside of *D*. Punch *E* descends and draws the shell down 7/8 in., producing the shell *F*. At that point of the draw the punch *G* comes in contact with the shell and cuts out the top as shown at *H*. Punch *E* goes on down and draws the shell *F* into the shell as shown at *A*. This reduces the shell from *B* to the shell at *A*, cuts the top and also flanges it up at right angles. When the press goes back on its next stroke, the pad *I* ejects the scrap, or disk *H*,



A COMPOUND DRAWING AND PUNCHING DIE

out of the die *D*, leaving it free to be pushed away with the next shell going in. Should the shell *A* stick in the punch, the knockout pin *JJ* will eject it from the punch.

This makes a positive working die from top to bottom. Pad *I* is worked by the spring *K*, and screw *L* prevents it from working up too high in die *D*. Die *D* is held down by three screws *M*. Ring *C* is hardened and ground and works around the outside of *D* with a nice sliding fit. Punch *G* is held in the outer punch *E* by setscrew *N*.

All the steel parts on a die of this character should be hardened, properly tempered and ground. In my judgment there can be no better working die for doing this class of work than that shown by this principle.

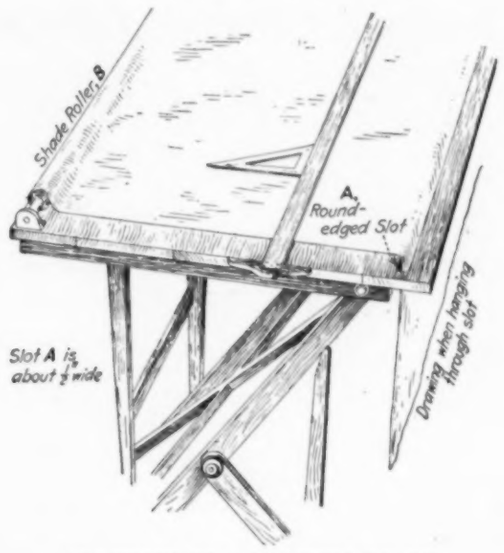
Dies of this kind very often eliminate one or two operations and do not put as much strain upon the metal as ordinary drawing operations do. The shell is perfectly level at the top, or at *O*, making a very neat shell.

Toledo, Ohio. JOHN R. SMITH.

Additions to a Drawing Board

It is a common thing for a tracing to come from the drafting room with a lot of creases and wrinkles on the surface. They will naturally show on the blueprints. These defects are caused by the tracing being pressed against the sharp edge of the board by the draftsman while lettering the drawing. Additions to the drawing board, shown in the illustration, should therefore prove valuable.

The slot *A* receives the drawing while it is being lettered, so that the draftsman cannot come in contact with the edge of the tracing and the board, thus eliminating the chances of creasing or wrinkling. The shade roller *B* receives the drawing as it moves up on the board, thus



ADDITIONS TO A DRAWING BOARD

keeping it from dropping to the floor. The roller, which can be made of wood, is attached to the board by two brackets. G. WEBER.

New York, N. Y.

A Lever, Its Fulcrum and the Machinist's Strap

When a farmer wants to pry up something, he takes a crowbar, a scantling or a fence rail for a pry, and a stone or a solid lump of something for a bait. He puts the bait, or fulcrum, as close up to the thing he wants to lift as possible and gets out as near the end of his pry, or lever, as he can. Why is it that the machinist and often the designer lack the sense to do the same thing?

Go into almost any machine shop and notice how work is strapped on the planer or the faceplate of the lathe; see where the bolts are placed in the straps. Nine times out of ten they are in the middle, where half of the strain on the bolt goes to hold the work and half to hold the blocking. If they were placed at one-fourth the way from the work and three-fourths from the blocking, three-fourths of the strain would go to hold the work; and if they were close up to the work, the strain would go almost wholly to hold the work.

Fig. 18, page 1160, Vol. 43, shows a design for a jig for holding a piece to be machined, where the bolt is in the middle of the strap. Of course the designer will say, "It does the job, and why kick?"

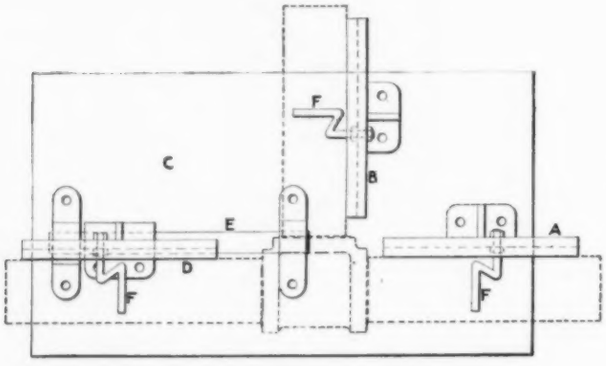
I have also seen cuts in the *Machinist* of straps for sale which showed a boss in the middle and a bolt hole central with the boss. I fancy the best all-around strap is one made of a square bar bent in the middle into a yoke, as in this the bolt can be placed anywhere along the entire length. It does require a washer on the bolt, which is no more inconvenient than sticking the bolt

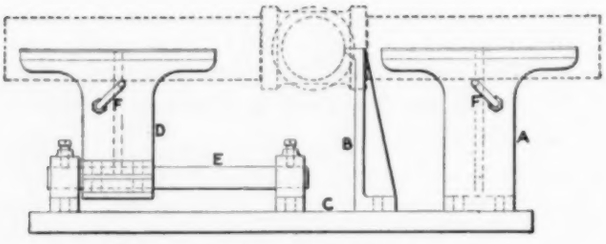
up through a hole in the strap. With T-head bolts for the slots in the planer, the nuts do not have to be removed from the bolts at all. JOHN E. SWEET.

Syracuse, N. Y.

Device for Testing Fittings

The illustration shows a device for testing screwed fittings to see if they have been tapped straight. The two brackets *A* and *B* are bolted to the cast-iron table *C* at right angles to each other. The third bracket *D* slides on a cold-rolled steel shaft *E* and is bolted to the table so that the edge is parallel with the bracket *A*. The bent iron rods *F* support the pipes which are screwed into the





DEVICE FOR TESTING SCREWED FITTINGS

fitting as shown. These rods are just tight enough for a slight knock with the hand to swing them up or down. The bracket *D* can be rocked on the shaft in the same way to suit reducing sizes.

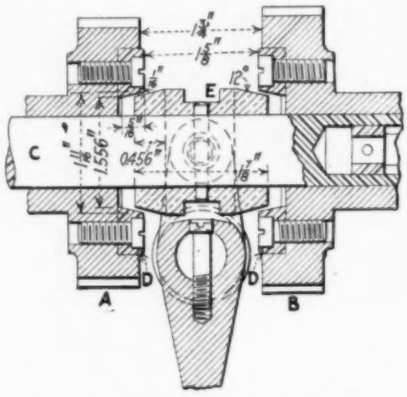
The man doing the testing needs no vise or square; he merely screws in his test piping and lays it on the machine which shows if the fitting is tapped out of alignment. This device is suitable for all sizes of fittings and will accommodate 90-deg., 45-deg. and 60-deg. elbows, straight or reducing; tees, reducing on run or outlet, or both; and bullhead tees and reducers, straight or eccentric.

Paterson, N. J. F. J. HIBBERD.

Two-Speed Friction Clutch

In adapting a machine for drilling and tapping, where it was found desirable to perform both operations without removing the work from the fixture, the two-speed clutch shown in the illustration was designed to meet the conditions.

The two driven gears *A* and *B* are keyed to the shaft *C*. The gears have a different number of teeth, according to the speed it is desired to obtain. On the inside of the gears is bored a recess, and the hardened and ground steel rings *D* are inserted, against which is forced the clutch roll *E*. This roll is keyed to the shaft and operated



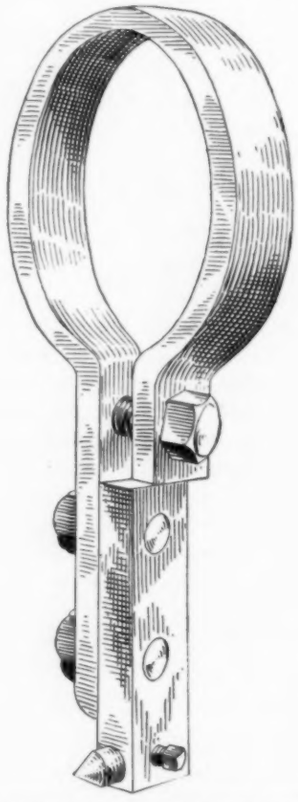
FRICTION CLUTCH FOR DRIVING TWO-SPEED SHAFT

by a foot treadle. The mechanism proved both efficient and economical. CHARLES F. SCRIBNER.

Hartford, Conn.

Miller Overarm Bracket

We wanted a light overarm bracket for a miller to hold a center for an arbor support, so that we could use a small-diameter mill and bring the center close down to



MILLING-MACHINE ARM BRACKET FOR HOLDING ARBOR IN CENTRAL POSITION

the work. The device was made of 2½x½-in. strap iron and a few screws, as shown in the illustration

Naugatuck, Conn. A. E. HOLADAY.

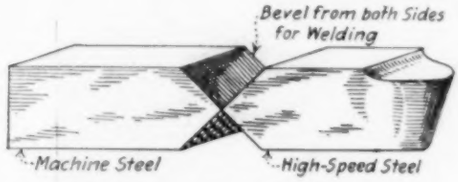
Discussion of Previous Question

Methods for Making High-Speed Steel Go Farther

The interesting article on page 123, in which various methods of conserving the limited available supply of high-speed steel are described, suggests recording some experiences that the Prest-O-Lite Co. has had along this line in welding high-speed steel tips to carbon-steel tool shanks.

The weld is made in the following manner: Both the machine steel and the high-speed steel are beveled from two sides by grinding, as shown in the illustration. It is important that this bevel extend clear to the center of the piece and that the angle be a generous one—at least 90 deg. It has been found that a nickel-steel welding rod made of a low-carbon steel containing about 3 per cent. nickel gives the best results, and no flux is used.

The weld should be executed just as though both pieces were of machine steel, except that greater care should be taken to insure the penetration clear to the center



BEVELING FOR WELDED TOOL

of the parts being welded; and it will probably be found necessary to "puddle" or "work" the molten metal with the filling rod, as some grades of high-speed steel do not flow readily under the torch. Wherever possible, the weld should be built up or reinforced, although in some cases this is impossible, as when the welded portion is inside the tool holder. In such cases the weld has to be ground off level. After the weld is completed, the tool can be ground and tempered in the usual manner.

A tool 1x1 in. can be welded, if properly beveled, in about 10 min. with a No. 6 tip. The oxygen consumption for this operation is about 5 cu.ft., and the acetylene consumption is approximately the same. On this basis the labor costs are 5c., acetylene and oxygen 10c. each, and filling material 5c.

I have never welded on any points of high-speed steel less than about an inch and a half long; but if the material is properly handled, I believe that this length could be reduced. It will be noticed of course that the procedure here described is somewhat different from the methods given in the article referred to and that a somewhat larger piece of high-speed steel is used. The process here shown, however, is, I believe, much easier for an inexperienced operator to carry out.

When it is remembered that since the beginning of the war the price of high-speed steel has risen from about 85c. to $4 per pound, the practice is worth considering.

Further, there are oftentimes short ends of high-speed steel that are not long enough for use. They are usually sold for scrap at about 35c. per pound, but may be used to advantage by this method. A. F. BRENNAN.

Indianapolis, Ind.

Spacing Grooves by Means of Lead Screw

On page 994, Vol. 43, Mr. Limbrunner describes a method of spacing grooves by means of the lead screw, and on page 1177 Mr. Miller offers another way.

We have been using in our shop for some time a method of spacing grooves which is simpler than either of those suggested. The lathe is geared up as if to cut a thread of the pitch of the grooves to be cut, and the tumbler is thrown into neutral position. We make a mark on the feed pulley and also a mark on the head of the lathe to correspond. After one groove is cut, the pulley is turned one revolution to bring the marks to register again, whereupon the next groove is cut.

This method is quicker that the others and requires no preparation except the making of two marks. It is as accurate as the lathe is, and any pitch may be divided without calculation. JAMES ELLIS.

Memphis, Tenn.

Best Way To Do Certain Things--Fastening a Lever

Prof. John E. Sweet's suggestion to compile all the best ways to do certain things is an excellent idea. There are, however, serious doubts as to what should and what should not be included, as the subject could be made so broad that no book could contain it all.

Concerning his best way of fastening on the end of a shaft a lever that is to be taken off quite frequently, there is a question in my mind whether a taper pin would not be better than a nut for fastening this particular lever. M. JACKER.

Stockton, Calif.

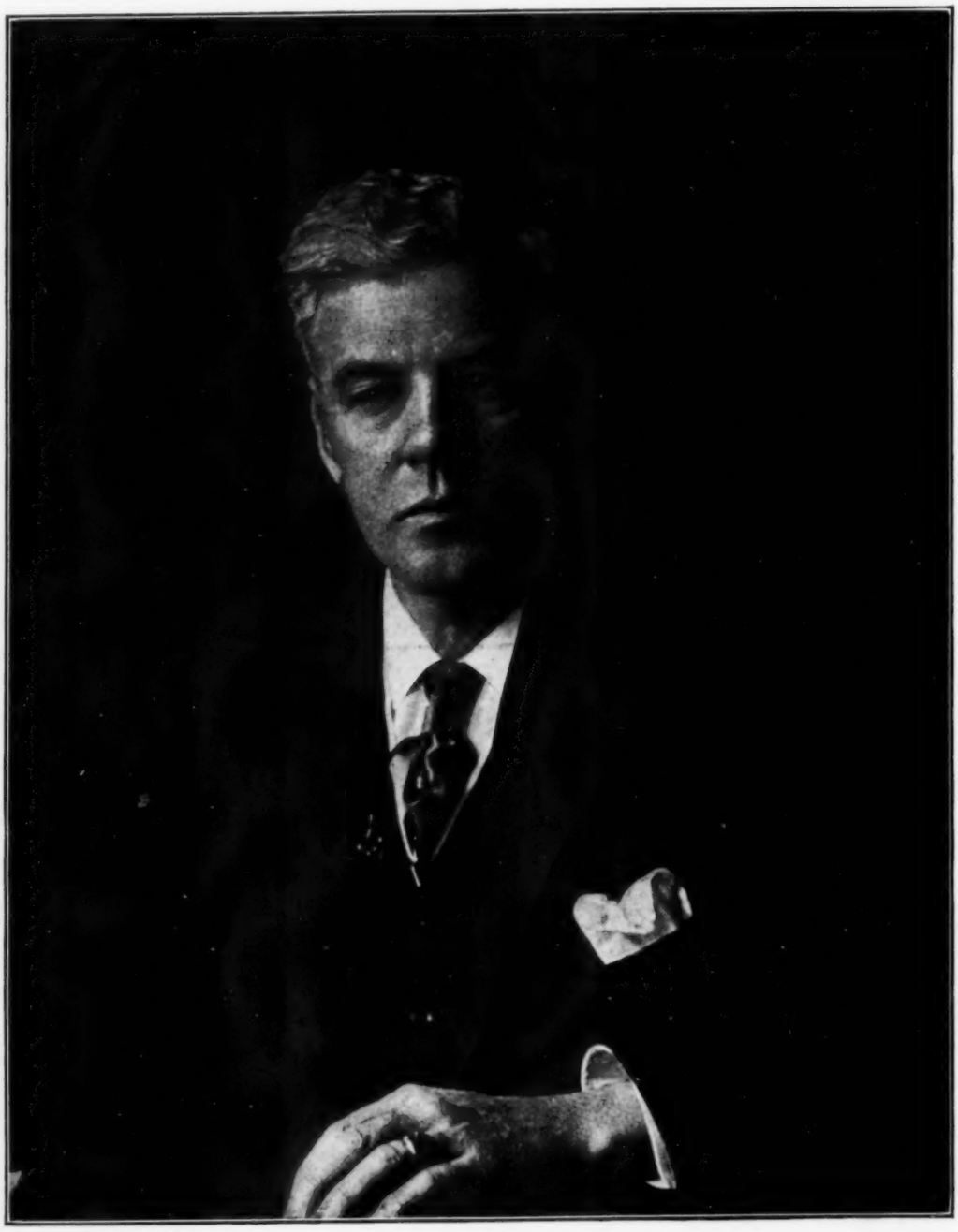
Patterns for Temporary Work

On page 1129, Vol. 43, I notice an article by L. M. Francisco on how to make a cheap pipe-elbow pattern, by building up in skeleton form and covering inside and out with a coating of tin or other thin metal and painting afterward.

It appears to me that the making of the skeleton pattern is O. K., but why the covering of tin? Is not this rather expensive, and would not the separate strips of tin represent a series of flats instead of a round shape, which I suppose is wanted in pipe work of that nature.

It would appear that such tin work would have to be formed into shape before being nailed to strips; after

(Continued on page 175)



John A. Reed

John Alexander Hill

John A. Hill, President of the Hill Publishing Co., died suddenly from heart disease on Monday morning, Jan. 24, while traveling in his motor car from his residence in East Orange, N. J., to his place of business. Mr. Hill had been engaged as usual in business affairs and was to all outward appearances in perfect health. Very few, even of his intimate associates, knew of the affection of the heart that resulted in his sudden death.

Mr. Hill was 57 years of age, having been born on Feb. 22, 1858, on a remote hill farm in the town of Sandgate, near Bennington, Vt. While he was a young lad, his parents emigrated to central Wisconsin, settling at Mazomanie. His childhood was that of the average boy on a small farm, and when eight years old he was intrusted with the care of a flock of 300 sheep. His education was that of a country school, which he attended for a few months during each of five winters. He early learned to shift for himself, and at 14 years of age went to work in a country printing office, of which he was foreman at 17. He had a Yankee boy's liking for mechanics, however, and after some years in the printing office he became half owner of a machine shop, where he carried on repairs to a variety of local machinery. At 20 he was seized by the "Leadville Fever" and spent about a year roughing it and prospecting. He then obtained a position as a fireman on the Denver & Rio Grande R.R., being promoted to engineer within a year. This was in the early days of that road and just before the great "Santa Fe war," when to drive a locomotive up the mountains and around the edges of canyons required both nerve and courage. Very soon the young engineer gained a reputation for more than ordinary ability and cool-headedness. These same qualities later on made him round-house foreman and assistant superintendent of motive power.

An opportunity for study presented itself to the young engineer when he was put in charge of the engine of a snow-plow. Its irregular runs gave him time for study, and he applied himself to railroad work and mechanics. Soon he began to contribute articles to the railway-engineering department of the *American Machinist*. His first article was published in the issue of May 23, 1885, under the title of "Oil for Locomotive Motions." The encouragement that came to him from the generous reception given to his contributions turned his thoughts more and more away from railroading and toward technical writing. In 1885 he founded the *Daily Press*, of Pueblo, Colo., and edited it for some time.

As a writer he had a forceful and breezy style and a thorough familiarity with practical matters. These qualifications, combined with a knowledge of the ideas and needs of the men in railroad work, enabled him to write articles which not only were well received in their day, but which live in book form.

At the end of the year's venture on the *Daily Press* he returned to the Denver & Rio Grande and ran an engine until 1887, when the *American Machinist*, deciding to start a monthly journal, the *Locomotive Engineer*, called him to be its editor. This brought him to New York in time to prepare for the first issue of 1888. Three and a half years later, in company with Angus Sinclair, Mr. Hill bought the *Locomotive Engineer* from the American Machinist Publishing Co. and changed its name to *Locomotive Engineering*.

The success of this journal under the new management was immediate, and was due in large measure to Mr. Hill's ability to give human and general interest to articles on mechanical and engineering subjects. Two notable series of stories that attracted wide attention were called "Jim Skeever's Object Lessons" and "Stories of the Railroad." Both of these were afterward reprinted in book form. His experience as an engineer had taught him the evils and showed him the inherent weakness of the old rule of railroad promotion—according to length of service. He strongly advocated a system under which specific subjects were studied each year and promotions made according to efficiency. This system he embodied in his work, "Progressive Examinations for Locomotive Engineers," which was later adopted by the American Railway Master Mechanics' Association as a standard form of examination on American railroads.

During the early years of *Locomotive Engineering* Mr. Hill was both editor and publisher. Although its success was phenomenal, his keen business insight showed him that a journal appealing largely to locomotive runners had not the elements for the largest kind of business achievement. He perceived a larger opportunity in the *American Machinist*, a journal of good standing and reputation, but which for years had been conducted along ultra-conservative lines. So in 1896, with Mr. Sinclair, he bought the *American Machinist* and a year later sold his interest in *Locomotive Engineering* to his partner, thus becoming the owner of the technical journal with which his name has been longest associated. This connection was the foundation for one of the largest enterprises ever established in the field of technical publishing.

At this time, 1896, practically all business publications had their printing done by contract and were limited by such facilities as the printers were willing to provide. Mr. Hill's early experience as printer and publisher had given his a strong liking for the mechanical, or manufacturing, side of the work, and he was ambitious that his publication should own and operate its own printing plant. In order, however, for such a plant to be commercially successful, its expense and effort must be spread over a number of journals.

It was this situation among others that led Mr. Hill to add to the already successful *American Machinist* other well-established technical journals of high reputation. His first purcahes was *Power*, in 1902. At that time this publication was a monthly journal devoted to the field of power transmission. Mr. Hill at once changed it to its present form and in 1908 made it into a weekly. In 1905 he became the owner of the *Engineering and Mining Journal*. A fourth journal, *Coal Age*, was established in 1911 to cover a field which had become too broad to be successfully reached by the *Engineering and Mining Journal*, which is chiefly devoted to metal-mining interests. In 1912 he purchased a fifth journal, the *Engineering News*, from its founder and chief owner, George H. Frost.

Meanwhile the influence of the *American Machinist* had been spreading abroad to such an extent that in

1900 a British company was formed to publish the European edition. Nine years later a German company was formed to translate it into German and publish it from Berlin. This made the *American Machinist* the most representative of the international technical journals.

An enterprise of Mr. Hill's last years, in which he took great pride and to which he devoted his best energy, was the construction on the west side of New York City of the great building to house his publications. This structure was completed in the latter part of 1914. It was characteristic of him that not only did he plan at every point to suit the convenience and economy of manufacturing in the printing and publishing business, but that he also made unusual provision for the safety, comfort and health of the army of workers that the building houses daily.

His initiative and leadership in the field of technical publishing are forcefully shown by the fact that many features of what is now considered best practice were inaugurated by him.

He was first in printing a circulation statement in each issue, in adopting the standard magazine size of page—9x12 in.—in discontinuing the acceptance of copies returned by news companies, in establishing an advertisers' service department, in discounting exchange advertising, in refusing to pay agents' commission on advertising contracts, in selling display advertising space on a flexible contract and in publishing a buyer's cyclopedia. Numerous mechanical improvements and developments in printing machinery are also to his credit. Both the rotary sheet-feed presses and the web presses used in his own shop were built by manufacturers according to his suggestions.

In addition to carrying on his own business he acted as mechanical engineer from 1900 to 1902 for the General Manifold Co., Franklin, Penn. Here he had charge of the building and superintending of the plant, the designing of special machinery and the development of continuous manifolding machines.

Mr. Hill was married in Wisconsin in 1882 to Emma B. Carlisle, who with one daughter survives him.

The story of Mr. Hill's life is a remarkable illustration of a man winning his way by sheer strength and ability. Born in the humblest surroundings and with only such education as was afforded by the country schools in the woods of Wisconsin nearly half a century ago, he well proved the saying of the president of one of the leading American engineering colleges that "life itself is an education." From his early boyhood, in whatever occupation he was engaged his personality was such that his associates instinctively recognized him as a leader, as a forceful organizer. In fact his capacity for organization was so great that he developed about him an organization for carrying on the manifold responsibilities of his five journals which easily carried all burdens during absences of several months at a time. The impression he made on those who met him was invariably that of a man of strength and force. While he was typically a self-made man, he had none of the objectable conceit which is simetimes supposed to characterize men who have risen to power from humble beginnings.

Mr. Hill was by nature modest and retiring. He was a genial man, fond of companionship and with an endless fund of good stories, but social life and club life had little attraction for him, and his two chief interests were the enterprise he had created, in which he took such pride, and his home. For many years it had been Mr. Hill's custom to write a Christmas greeting that reached every employee on the afternoon before the holiday. The one for last Christmas is so typical of his kindly interest in those around him, as well as showing the individuality of his literary style, that it is quoted below:

"The year 1915 is almost gone; it has brought more loss, suffering, death and despair to the human race than any other year of all recorded time, and yet, it has been good to us.

"We have not done so well as in former years, yet we have done well.

"We are all here—not a funeral or a serious illness in our ranks. Most of us are warm and eat regularly—Allah be praised!

"All signs are favorable for better times, the optimist is in charge and the pessimist has been run over by the steam roller that is making the road to business clear—this concern is full of hope and that 'Christmas feeling.'

"Most people dislike to get a bill at this time of the year, but here's one that you need not pay, so we think it will be welcome.

"With it goes a 'thank you' for every little item of service you have furnished this past year which has gone to make up the million-dollar mosaic that this company has made out of all our little items of service combined.

"If your heart and mind be charged with as much good-will, love and respect for the Hill Publishing Company as the institution has for you, the next year will be comfortable and happy for the whole works—big wheels, little wheels, case and fob."

Mr. Hill was essentially a man of broad human sympathies. He took a fatherly interest in the welfare of his employees and delighted to have them refer to him as "The Old Man," a term to which he indeed gave wide currency in his early writings on experiences in machine shops and locomotive roundhouses.

Mr. Hill was a member of the Engineers' Club, of New York City, Vice-President and charter member of the Machinery Club, member of the Railroad Club and of the Campfire Club. In 1913 he was elected a member of the American Society of Mechanical Engineers, among his references being Thomas A. Edison and James Hartness. He was first and only president of the McGraw-Hill Book Co., chairman, Hill Publishing Co., Ltd., of London, and president, Deutscher Hill Verlag, A. G., Berlin, publishers of Maschinenbau, the German edition of the *American Machinist*. As a young man he was greatly interested in the National Guard, although not a member. During the last year he was Vice-Chairman of the Committee of Engineer Reserve Corps of the American Society of Mechanical Engineers, charged with the duty of working out the details of a plan to create a corps of civilian engineers for emergency service for the United States Army.

The esteem in which Mr. Hill was regarded by his employees was put into words engraved on a bronze tablet over an ornamental fountain presented to him soon after the new Hill Building was completed. This is the inscription:

"Within this monument to independence, truth and service in engineering journalism the employees of the Hill Publishing Company have placed this tablet—an appreciation of the man and employer, John A. Hill."

Shop Equipment News

Heavy-Duty Projectile Lathe

Although the lathe shown was designed particularly for the heavy duty imposed by shell turning, its rigidity and general operating details are calculated to provide a machine well adapted for a variety of other classes of work.

In the headstock, to obtain unusual rigidity, the lower gear casing is designed to form connecting members between the front and rear main spindle and driving-shaft bearings, insuring a section free from longitudinal vibration. The spindle is of special steel, ground to standard size and bored from the solid forging. It runs in renewable phosphor-bronze bearings. The thrust bearing is formed by alternately arranged heat-treated steel and phosphor-bronze washers. Driving gears on the spindle are of cast steel with cut teeth. The driving shaft also journals in bronze-bushed bearings. The two pinions are integral, being cut from a solid forging. They slide on a feather key and are operated by a hand lever.

The proportions of the bed, combined with U-shaped internal bracing, provide rigidity. To facilitate quick removal of the tailstock, or turret, the bed is cut away at the rear end.

The apron is shouldered into the carriage over its entire length. It is held by six screws. All apron gears are of steel; those running on steel studs are phosphor-bronze bushed.

The tailstock is braced, and the construction of the nose clamp is such that the tailstock spindle is always in its correct position. The spindle is of large diameter and has a phosphor-bronze nut on a medium-pitch screw, which, with the large handwheel, facilitates easy drilling of holes of large diameters. Adjusting screws permit use of the tailstock for taper turning. The tailstock is moved along the bed by a removable pinion engaging the rack.

The lead screw is of high-carbon steel, chased to standard size. The nut is of the split pattern and is babbitted. Thrust in both directions is taken by heat-treated steel and phosphor-bronze washers alternately arranged.

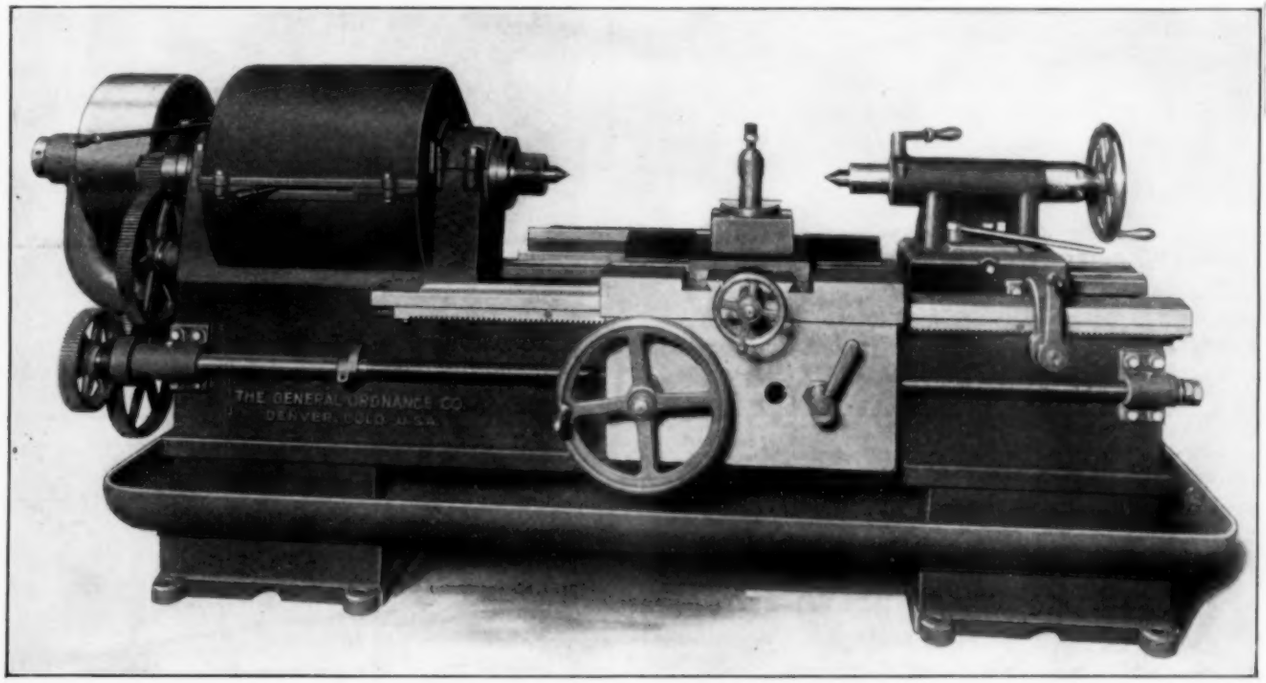
A wide variety of special equipment particularly adapted for shell work can be supplied, a most noteworthy attachment consisting of a four-way turret tool post. The lathe may also be secured with four-speed selective headstock and quick feed-change gear box.

The machine, with 8-ft. bed, weighs 8,000 lb. It is a recent product of the General Ordnance Co., Denver, Colo.

Plain Bench Miller

While primarily intended for light work, the machine shown is heavily proportioned for its size.

The spindle is machined from a 3-in. solid steel bar and has a ¾-in. hole taking a No. 10 Brown & Sharpe taper. The bearings are provided with adjustment for wear, and lubricated by a felt wick extending the entire length of the box and down into the oil wells provided.

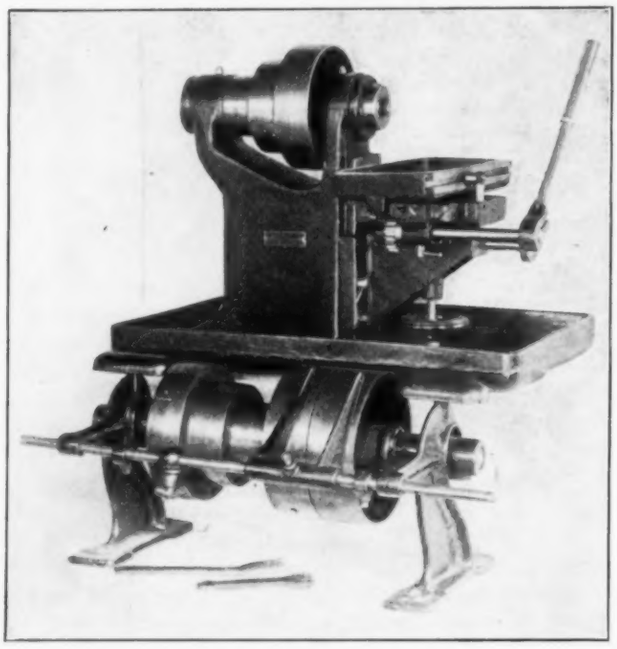


HEAVY-DUTY SINGLE-PURPOSE PROJECTILE LATHE

Swing over shears, 22 in.; swing over carriage, 13¾ in.; distance between centers, 3 ft. 2 in.; hole through spindle, 1⅜ in.; pulley diameter, 20 in.; width of belt, 8 in.; feeds, 1/16, 3/32, 1/64 in. per revolution; for cutting speed of 75 ft. per minute on 6-in. shell; main spindle, 44 r.p.m.; driving shaft, 220 r.p.m.

The table has a T-slot through the center and is arranged in a pan form to catch the oil and chips. The table is actuated by a steel rack and pinion with a hand lever on the pinion shaft which can be set so as to bring the handle in the most convenient position for the operator. A table stop is also provided.

The part of the saddle that protrudes in front of the table is machined, making it convenient to attach such



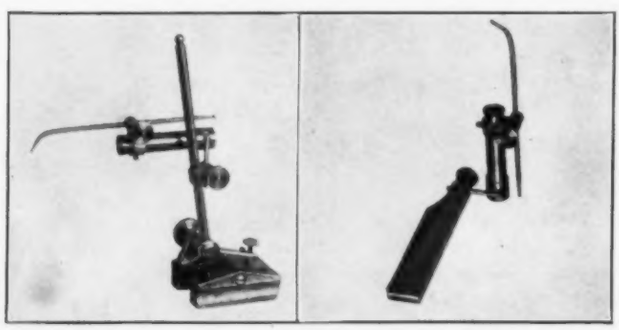
PLAIN BENCH MILLER
Table 4 in. wide, 12 in. long; 3-step cone pulley in spindle; largest diameter, 8 in. for 2-in. belt

fixtures as are often necessary in the manufacture of special classes of work. The knee is elevated by the handwheel underneath.

The machine is set in an oil-pan base and is regularly furnished in two forms—namely, with cone pulleys and countershaft, or with plain 6 in. diameter pulley on the spindle to be belted from a 6-, 8- or 10-in. pulley under the bench. On the latter the belt is entirely incased within the machine by guards and hood, the belt passing down through a special pan.

Electric Test Indicator

The feature of the universal test indicator shown is the electric-light attachment designed to avoid eye-strain and insure certainty in watching the contact of the needle of the surface gage with the work to be accurately finished.



UNIVERSAL ELECTRIC TEST INDICATOR

At the instant the ball point of the needle touches the highest point of the job, either internal or external, the light in the end of the tube flashes, indicating the direction in which the job must be moved. After the work is trued, the light will burn continuously.

The lightest touch of the needle will cause the light to flash. The indicator is self-contained, as the battery to produce the light is inclosed in the main body of the indicator in direct contact with the bulb, without any wires or connectors, and can be renewed at small expense.

As shown in the illustration, a holder is supplied to use the indicator in a toolpost where it would be inconvenient to use a surface gage. The tool is a recent product of J. G. Xander, Reading, Penn.

Electric Rivet Header

So much is said about electric spot welding that few realize that an electric machine may be used to advantage for heating and heading rivets, where spot welding is impracticable. Such a machine, used for riveting gears and plates together, is shown in Fig. 1. This machine is made by the Toledo Electric Welder Co., Cincinnati, Ohio.

The rivets are inserted in the holes, each in turn placed under the dies of the machine, and the current turned on by means of a switch in the operating lever. In a fraction of a second the rivet is heated a bright red, the

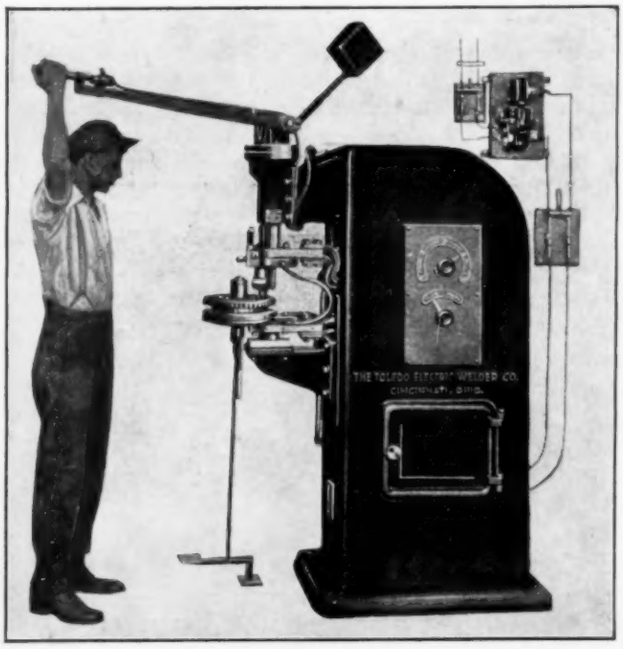
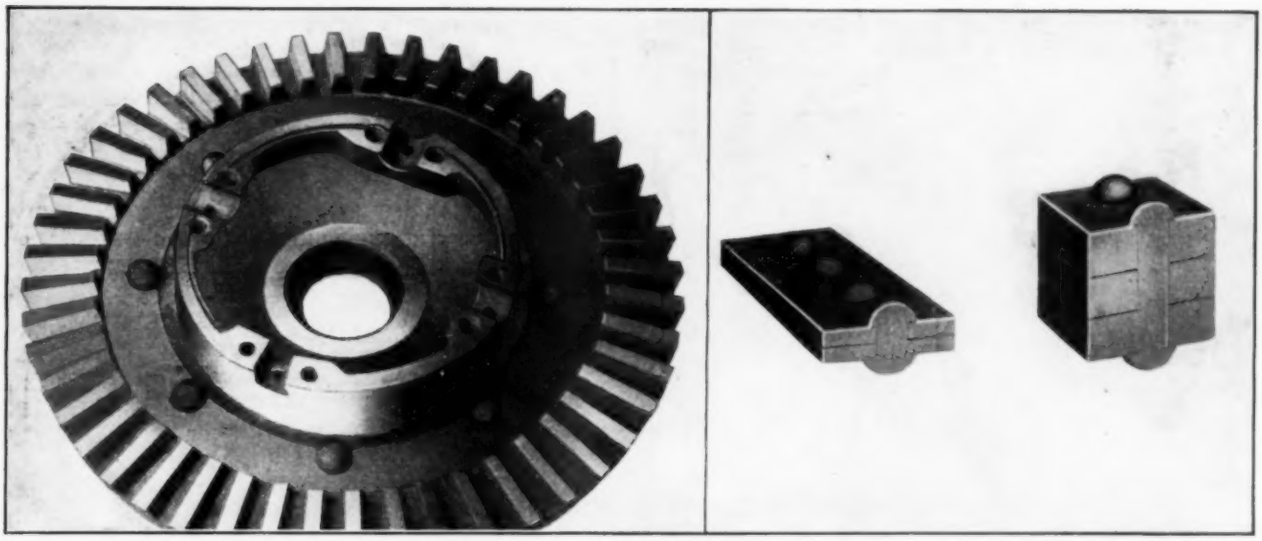


FIG. 1. ELECTRIC RIVET HEADING MACHINE

operator pulls down on the handle, and the head is formed. The current heats the rivet from the center to the outside, which is just the reverse of the ordinary way of forge heating. There is no overheating or burning of the rivet, as the operator turns off the current the instant he sees it is hot enough.

A view of one of the gears riveted in this machine is shown in Fig. 2, and Fig. 3 shows some pieces that have been riveted and the end rivets sawed endwise to illustrate the perfect heads thus formed.



FIGS. 2 AND 3. SAMPLES OF RIVETED WORK DONE ON ELECTRIC HEADER

By means of a special regulator at the side of the machine the current is under control, and rivets may be heated to a dull cherry red of about 1,200 to 1,300 deg. F. By changing the setting of the regulator they can be brought to a bright cherry red equal to about 1,500 or 1,600 deg. F. If desired, they may be heated still hotter, or about 2,000 deg. F. The operator has the current under control, and any rivet of the same size will be heated to the same temperature in the same length of time.

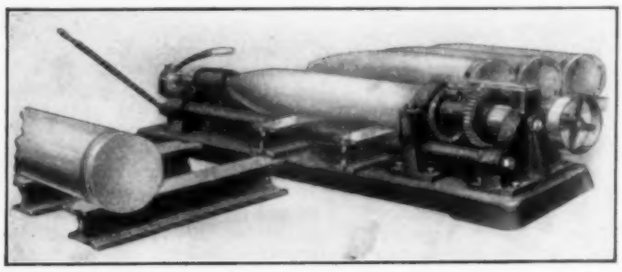
Machinist's Foot-Lever Vise

A quick-acting machinist's vise operated entirely by foot power represents a recent development of Fisher & Norris, Trenton, N. J. The foot control is designed to enable both hands to be used freely in lifting and inserting work in the vise.

The vise consists of a standard bench vise equipped with a pedal attachment which provides the movement for the jaw. It can be used with any bench, the length of the standard being varied to suit conditions. The use is made in a number of sizes.

Large Shell Marker

The machine shown represents the latest addition to the line of marking machines made by the Noble & Westbrook Manufacturing Co., Hartford, Conn. It has been developed especially for marking the base ends of heavy shells.



LARGE SHELL MARKER

A platform or rack can be built on each side, and the shells will then roll into the machine. Only a few seconds are required for the marking, after which the operator pulls the lever provided with cam adjustment, which automatically raises the shell from the machine, and another shell falls into place.

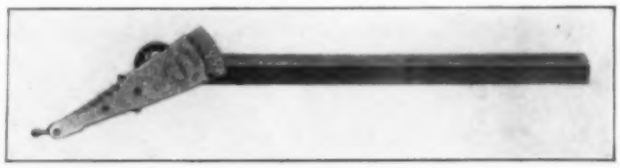
Another feature is in the die. Each letter is separate in the machine and can be removed or replaced without substituting a new die.

The machine runs by power with tight and loose pulley, and no countershaft is required.

Universal Test Indicator

The universal test indicator shown requires little explanation as to design and application.

The contact point can be turned to any desired position in relation to its axis, in order to provide readings for the wide variety of work to which a tool of this kind can be



UNIVERSAL TEST INDICATOR

applied. To reverse the direction of the reading, it is only necessary to grasp the indicator by the two ears, shown projecting from the indicator body.

A friction device protects the contact point from accident, so that if the work to be tested is jammed or pressed too hard against the contact point the latter automatically swings out of the way.

The scale is graduated in thousandths, with divisions $\frac{1}{16}$ in. apart. All bearings are bronze-bushed to prevent sticking.

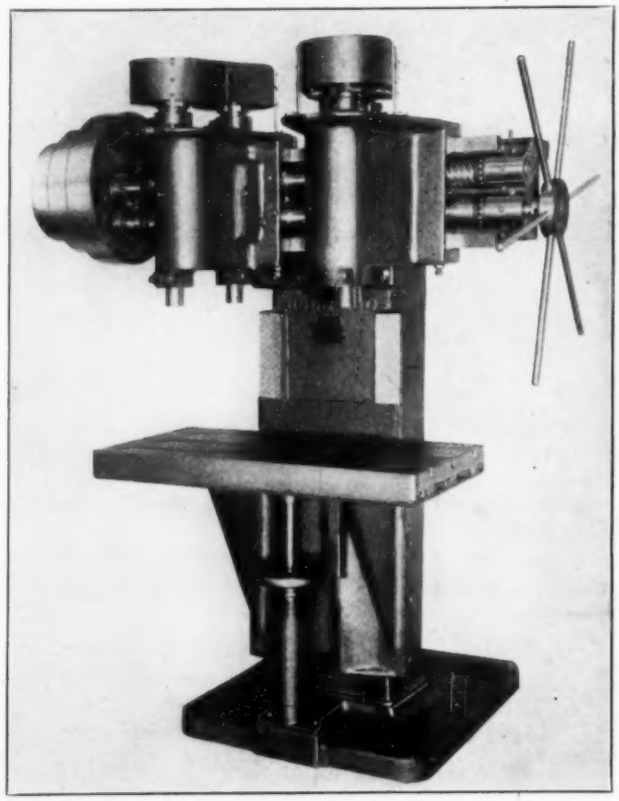
The indicator is a recent product of Johnson & Miller, 42 Murray St., New York, N. Y.

Four-Spindle Miller

The four-spindle miller shown is a recent adaptation of the drilling machine made by the Moline Tool Co., Moline, Ill.

The spindles are driven by the standard spiral drive incorporated in the drilling-machine line made by the builder mentioned. The heads are traversed to and from

each other by right and left cam grooves in a shaft below the driving spiral. Hand feed only is provided, as operations ordinarily done on a machine of this kind are light and quick-action and power feed seldom necessary.



SPIRALLY DRIVEN FOUR-SPINDLE MILLER

Table, 32x15 in.; length of rail, 3 ft.; maximum distance between spindles, 3 ft.

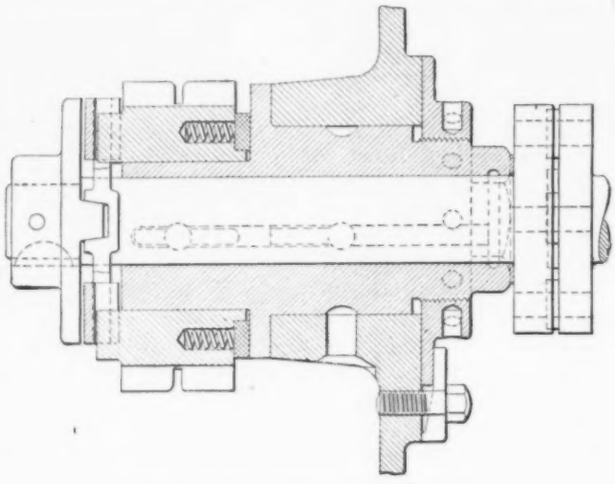
Special heads with any desired arrangement of spindles can be provided. The table is plain or oil grooved and is provided with T-slots.

Improved Oldham Coupling

Often a simple modification in an old, well-known but only partly successful device for certain purposes makes it completely serviceable in the newer applications. When we find such a development, we are apt to ask why no one thought of it before.

The Oldham coupling has been known for generations. Its early applications were on transmission shafts in mills and on propeller shafts of steamships. To a limited extent it has been used in general machinery. In its regular form the jaws are straight-sided and fit into grooves of similar shape. There must of necessity be some looseness between the male and female portions to permit movement, and as a result a greater pressure exists on the largest periphery of the driving portion as it tends to take a position at a slight angle to the groove, and in effect produces substantially line contact. This results in quick beveling off of the outer driving face of the male portion and carries the point of contact back toward the center. Again this process of wear produces a rounding or convex surface, and as the point of contact moves toward the center the pressure of driving constantly increases, with the result that the old type of Oldham coupling may quickly become loose, rattle and cause trouble. As a result it has been substantially discarded from all points in automobile construction where a material movement of the floater exists, and its use has finally been restricted to places where a lack of alignment of a few thousandths of an inch must be cared for.

The Morse Chain Co., of Ithaca, N. Y., has just put on the market an improved form of this coupling provided with a beveled driving member, which bears only on



IMPROVED OLDHAM COUPLING

the adjoining sides of the beveled edges, the total angle being 15 deg. There is no bearing on the bottom, as it is cleared at this point for take-up purposes. The two members are held in intimate contact by spring pressure the amount required being about 5 per cent. of the total amount of the drive; that is, if the pressure on the sides is 100 lb., a spring pressure of 5 lb. will always keep contact. The device has been run up to 3,000 r.p.m. and is efficient for power transmission up to pressures, for phosphor bronze, of 250 lb. per square inch, and for hardened steel, or 450 to 500 lb.

The illustration shows this coupling as part of an adjustable sprocket wheel for a chain drive. The amount of adjustment is enough to keep the chain at proper tension until the stretch is equal to the length of one link. A link is then removed and the adjustment of the sprocket set for the new chain length; further adjustments are made as they become necessary through further stretch.

Cast-Iron Castings, as indicated in a paper read before the International Engineering Congress, are chiefly used where great strength is not required of the material or where light weight is not necessary, so that the weakness of the material can be allowed for by increasing the size of the sections. There are two general classes of iron castings—plain gray iron and chilled iron. The latter material is produced by casting gray iron of suitable composition against heavy iron "chills," whereby the part chilled is rendered extremely hard and, incidentally, brittle. The somewhat gradual transition from chilled to gray iron in the casting and the soft gray-iron part of the piece give sufficient strength to the casting, as a whole, to prevent its breaking in service. Of course a casting chilled all the way through would generally be too brittle to be of any use. Chilled castings are largely used for car wheels; rolls for rolling-mill, paper-making and other machinery; for wearing parts of crushing and grinding machinery, etc.

What's the Matter With Our Methods of Threading?

By P. W. Abbott

SYNOPSIS—A study of the various elements entering into the production of good threads, both internal and external, which points out the reasons for defects and the remedies for correcting them. The taps and dies, the speed, the amount of metal removed at one cut, the size of the blank, the effect of the machine and lubricant are all considered, and the suggestions given should prove very helpful in many shops.

"What's the matter with our methods of threading?" Your editorial on page 1092 touches a very vital issue and one that has been neglected in most shops in this country. Yet the fundamental rules governing the producing of threads on threading or tapping machines, automatic or hand screw machines are no different from those for producing accurate turning, forming or reaming. But just as long as manufacturers of parts and machines could get by with the class of threading which they have been doing, this all-important subject has not had the study that other machine-shop operations have had.

I have investigated the threading problem very extensively and have seen the class of threading done by most of the representative firms in this country, and there are very few who really know the fundamental essentials of producing clean, accurately cut threads. Whenever exacting interchangeable threading limits are mentioned to the average firm doing this line of work, the first answer is, "Impossible!" The next is, "It cannot be done without hand dieing or hand tapping;" and the next, "Think of the cost!"

Just as accurate work can be done in machining threads as on plain cylindrical work, at no greater cost than poorly cut threads and without the necessity of any hand work. The first item that needs consideration is the tap and die. Accurate work cannot be done with the commercial taps and dies sold by the tap and die manufacturers at the present time. This condition is in a measure the fault of the users, as they have not been trying to produce high-grade threads, contending that they are doing as good threading as can be done and maintaining the attitude, "Threads is threads."

All of this munition and other work on which our manufacturers have found it necessary to do hand threading or tapping could be done satisfactorily on the machine with the proper tools. The first thing necessary is to use the correct dies and taps. In speaking of dies, round adjustable or button dies are meant, as they are the most economical for use on automatic screw-machine work up to 1 in. in diameter.

Specifications for Accurate Dies

The following specifications will insure good results: The threads in dies shall be burnished smooth after hardening, to remove the hardening scale and to correct the lead. After this the dies shall be ground on outside diameter and on both sides true with pitch diameter. That means that they shall be ground from the thread itself.

The die should be 0.005 in. oversize on pitch diameter, as a die can be closed to make the thread smaller but cannot be opened successfully to cut a thread over the size the die was originally made. It should cut a thread whose lead will not vary over 0.002 in. either way, in one inch. The adjusting slot in the die will be a 60-deg. V and perfectly plain on the outside diameter, with no depressions for the points of the adjusting screws. Taps should be straightened after hardening, to be within 0.002 in. on the pitch diameter and to show correct for lead within 0.002 in. either way, in one inch.

For use in the automatic screw machine for accurate threading, the round adjustable or button die is the most suitable, self-opening die heads being applicable only to automatics on large, slow-moving work.

Desirable Limits of Accurate Work

By accurate work I refer to threading or tapping done to the following limits: Pitch diameter to be within 0.002 in. for size, and for lead to be within 0.002 in. either way, in one inch, up to $\frac{9}{16}$ in. in diameter; beyond that a 0.003-in. limit on pitch diameter. There is not one thread maker in one hundred who could make parts commercially to these limits; yet it can be and is being done on a large scale by two manufacturers in the Middle West, one a screw maker and the other an automobile manufacturer, representing both phases of the question.

For hand screw machines the time element for threading has to be considered, as time is lost in letting the die run off from the work; therefore it is an advantage to use self-opening die heads. However, the problem of cutting accurate threads with a die head is a much harder one. It requires more care to cut good threads with a self-opening die head than with round adjustable dies, as we then have the errors in the die head to contend with, particularly after it begins to wear. Die heads and taps are made which will give accurate results, but they cost more than many are willing to pay.

Use Roughing and Finishing Cuts

Coming to the question of roughing and finishing threads, no one would think of turning accurate plain cylindrical work without taking more than one cut. Yet the average manufacturer will scoff at the idea of taking roughing or finishing cuts on threaded or tapped work, as the force of habit is so strong. His attitude is that as dies and taps are made to thread a piece or tap a hole in one cut, it ought to be done in that way.

Accurate holes cannot be tapped in one cut, either by hand or machine, but they can be tapped with a roughing and a finishing tap, the roughing tap being 0.010 in. smaller than the finishing tap. On large work of, say, 12 pitch, two dies should be used—a rougher and a finisher—and there are very few automatics that cannot be rigged up to do this with the exercise of a little ingenuity. Some makers make a regular outfit for an

extra threading spindle, which on the multiple-spindle machines means no extra time for doing the operation and gives a superior finish.

The choice of lubricant is not so vital as is the matter of proper dies and taps and the holding equipment for them, for if the dies and taps actually cut, almost any lubricant will do. For screw stock, ordinary paraffin oil is as good as anything. For the low phosphorus and sulphur and higher-carbon stocks, use any of the good mineral lard oils and screw-cutting compounds. None of the fancy high-priced oils are needed.

This so-called great question of lubricant has arisen from the use of taps and dies which do not cut, but push or force the metal off and out of their way. If the tools are actually cutting, all that is needed is something to keep the work and tools cool, the freer flowing the better—and lots of it. The correct method is to direct the oil under pressure through the threading spindle and out of the front, or cutting side, of the die, preventing chips from getting into the die and holder to clog and damage the die and threads. This is the fault with a great deal of our poor threading.

The average manufacturer's idea of a lubricant on a die is a small stream about ⅛ in. in diameter falling by gravity from overhead. For machine tapping, one or two squirts from an oil can are considered sufficient. But for machine tapping holes, say, up to ½ in., a stream about ⅜ in. in diameter under pressure should be directed on the tap at the edge of the hole. As for the lubricant's affecting the size—if the die is actually cutting, any lubricant could be put on successive threads and they would all be of the same size. If there is a variation from thread to thread cut with a die, the fault lies with either the machine or the holder, or there is a wide variation in the hardness of stock being used.

The Question of Correct Lead

There is just one thing that affects lead, and that is the tools doing the thread cutting. If the taps, dies or chasers have the correct lead, the work will also be correct. I have seen different schemes tried for changing the lead of external threads cut with dies or chasers, with absolutely no results, the thread simply being distorted in form but the lead remaining the same. When a manufacturer starts to buy his dies and taps to lead specifications he can forget his lead troubles. To know what one is doing on the lead question, means must be provided for measuring the lead.

The saw-tooth gages are good, as they will show whether the lead is good or bad, but not how good or bad. By these gages I do not mean those that fold up like a pocket-knife, as they are only good to give the number of threads per inch. What is wanted are those about 1 in. wide and 1½ in. long, with the teeth milled the full length. These give the operator the proper length to measure. They should be just as long as possible up to 1 in., which is plenty long enough. There should also be a lead-testing fixture in every department cutting external threads. This fixture reads the lead in thousandths, showing the error in a minimum of time.

It is not cataloged, but it is the last word in lead measurement. If the lead on the thread looks bad to the operator with the saw-tooth gage, or at all off, he tries it in the lead-testing fixture; if it is beyond the limit, he removes the die and sets another.

There is a tendency to do threading too fast on multiple-spindle automatics. This is usually the fastest operation anyway. All the time possible that the other operations allow should be taken for threading. If the other operations are shorter, they should be sacrificed rather than have the threading done beyond a sane, conservative speed.

A little thought on comparing the accuracy wanted with the amount of stock removed will show the folly of trying to do threading at too fast a speed, and the same is true of tapping. It is very necessary that the proper size of tap drill or boring size be used for each size of hole to be tapped. This matter should be worked out very carefully, giving the maximum size of hole for each particular diameter and pitch.

The same is true of the outside diameter, which should be turned smaller than the size of the screw—that is, the size for a ⅜-in. by 16-pitch screw would be 0.368-0.372 in.; and for a ⅜-in. by 20-pitch screw, it would be still different. These sizes should be worked out carefully, as they are very important and materially affect the accuracy of the threads being cut. They should be held within a close limit. To the average screw maker or manufacturer, a ⅜-in. screw is one turned ⅜ in. with a pair of calipers set to a scale. It is just as liable to be 0.010 in. over as under.

The Spring of Dies and Die Heads

A die or die head is held together by parts that can spring under pressure, and this pressure is exerted when the die passes over the work. Naturally if the work is oversize, more pressure is exerted, the die springs open, and the thread is large. If the next setting of the box tool is so that the work is small, the thread will be small also, as the die does not spring so much. For work up to ½ in. the outside diameter for threads should be held within a 0.004-in. limit; for ½ in. up to 1 in., within 0.005 in.; and for 1 in. up, within 0.006 in.

Another factor along the same lines is the quality of stock. If this varies in hardness, the threads will vary also, due to the spring of the dies. Stock should be purchased to exact analysis and Brinnel hardness within reasonable limits for both bar stock and forgings. Accurate threads cannot be expected on forgings if the analysis is not the same in each lot, or if they have not been properly annealed or heat-treated to bring them within a close range of even temper or homogeneity. The same is true of the material to be tapped, if it is not even in temper or structure.

Tools Should Be Held in Alignment

The holes will also vary if the size of the tap drill hole varies. Tap drill holes should be held within a limit of 0.004 in. up to ½ in.; and within 0.006 in., beyond that size. If the tap drill hole runs large, the tap will cut to size, but part of the thread will be lost. If it runs small, however, the tap will cut oversize, due to the crowding of the metal, even though the tap is properly made. The average manufacturer, if one size of drill is out of stock, decides that the next one will be just as good; and then he wonders at the variation in the size of tapped holes.

Next in importance to the tools to do the work with is the manner in which they are held and how well they are kept in alignment. The average die holder on screw machines or turret lathes is usually in very poor con-

dition, mostly home-made and poorly made. There is, however, one good die holder made in this country, with careful thought as to cutting accurate threads. All parts are hardened and all vital parts ground after hardening. The front end of the holder or body, which is so vital, is ground true with the shank, and the shank is of ample length, insuring that the die will be presented squarely to the work.

To make sure that the die will line up centrally, a plug should be made, hardened and ground. This screws into the cap, a projection on the end of the plug being ground the exact diameter of the outside diameter of the die. The adjusting screws in the cap are screwed down until they just touch this plug, the plug is then unscrewed from the cap and the die pressed by hand inside the adjusting screws. If adapters have to be used between the die holders and the hole in the turret, they should be hardened and ground; and they should have long shanks so that they will not tip when the turret clamps tighten on them.

It is of vital importance that the turret holes be in line with the work, as the less "float" you have to use in the die holder the better the threads will be cut. For with the holder tipped at an angle when it starts on the work, to make up for nonalignment, the die will not cut properly. If the die holder is used in the type of automatic in which the die revolves, it is of prime importance that the spindle run true, and of equal importance that the work run true. Accurate threading cannot be done if either the work or the die runs out of true, yet in the average shop one will find both these errors existing.

The same is equally true in the tapping of holes. The hole and the tap should be so held as absolutely to line up with each other, yet in the average shop this receives the least attention as long as the tap finally strikes the hole. That is all that is looked out for, and very little attention is paid as to whether the tap is straight or crooked.

Little Trouble with Machines Themselves

We come next to the least of our worries in producing good threads—that is, the machine they are to be produced in. Accurate threading or tapping can be done in any of the recognized types of machine tools, providing they are in such condition that the spindle doing the threading or tapping can be kept in alignment with the work. That is all that is necessary.

Most of the manufacturers making war munitions have learned that their thread cutting is not good enough. The next step will be for them to learn that it can be made good enough without hand dieing or hand tapping—that it can be done right in the machine.

I would also call attention to the fact that there are inherent defects in both the V and the United States Standard forms of thread, preventing parts made to either of them from being as accurately fitting as they might be, owing to the interference at the top and bottom of the thread. No clearance is allowed in either. Some trouble is also due to the different tap and die manufacturers' interpretations of these two forms of threads. The best way out of this trouble would be to use the form of thread that has been discussed in your columns under the title of "The Cadillac Form of Thread." It has no interference, but fits on the pitch diameter.

PERSONALS

Edward Kountz, who has been general foreman of the Cincinnati Shaper Co., has been made acting superintendent, succeeding N. B. Chase.

Maynard D. Church has been appointed chief engineer of the Terry Steam Turbine Co., Hartford, Conn. Mr. Church was formerly chief engineer of the Dayton Turbine Pump Co., Cleveland, Ohio.

N. B. Chase, for many years general superintendent of the Cincinnati Shaper Co., Cincinnati, Ohio, has been elected vice-president and general manager of the Fosdick Machine Tool Co. of that city, succeeding William Herman, who on account of ill health has retired from active management.

OBITUARY

Austin D. Mixsell, vice-president and director of the Bethlehem Steel Co. and president of the Dietrick & Harvey Co., of Baltimore, a subsidiary concern, died Jan. 14.

J. F. Conradi, supervising engineer of the Maxim Munitions Co., died in New York City on Jan. 12 as the result of an attack of pneumonia. Mr. Conradi came to the United States several years ago after an extended experience with the Maxim-Vickers Co. of England.

George H. F. Schrader, well-known inventor, and formerly president of A. Schrader's Son, Brooklyn, N. Y., which was founded by his father in 1844, died en route from Iceland to Norway about two months ago. Mr. Schrader was inventor of the universally used valve for pneumatic tires. Since his retirement from active business he has devoted his time and fortune to philanthropic purposes.

Asa S. Cook, president and treasurer of the Asa S. Cook Co., Hartford, Conn., died on Jan. 13. Mr. Cook was born in Sandwich, N. H., in 1823, and when 27 years old went to Hartford to take up work in the Colt's Armory. Shortly thereafter he became interested in wood-screw manufacture and invented several machines for their production. In 1858 he established his own business for the manufacture of wood-screw machinery.

Edward Wright, founder of the Wright Machine Co., and for half a century a resident of Worcester, Mass., died at his home in Worcester, Sunday, Jan. 9, 1916. Born at Glen Cove, Conn., in 1835, he began work at the early age of six years as a mill hand. He moved to Worcester in 1855 when he began his career as a mechanic and inventor. He was granted over 60 letters patents in the United States and in foreign countries, many of which are in extensive use at the present time. Among the best known are improvements in textile machinery, wool-carding machines, water-wheel and steam-engine governors. He was the originator of the self-operating spinning machine which in the early seventies founded the business of Johnson and Bassett and which revolutionized the wool-spinning industry. Later he invented another form of spinning machine somewhat different in character now built by the Davis and Furber Machine Co., of North Andover, Mass., and for some years was connected with this firm as mechanical expert and inventor in the design and perfecting of textile machinery.

Patterns for Temporary Work

(Continued from page 165)

being applied, would there not be danger of their being flattened by accident of some kind or by the molder's rammer?

A pattern of this kind should be made up of straight pattern form for standard use; but if wanted for use only once or a very few times, it could be made up to be swept out of sand, or it could be made up in skeleton form (much as Mr. Francisco describes, with the exception of the tin) and both core and mold strickled out. Flanges or any side or other outlet or inlet parts that come off loose might be held on the skeleton pattern by long dowels.

Boston, Mass. John Parker.

Prices--Materials and Supplies

Pig Iron—Quotations were current as follows at the points and dates indicated:

	Jan. 21, 1916	Dec. 23, 1915	Jan. 22, 1915
No. 2 Southern foundry, Birmingham	$15.00	$14.50	$9.50
No. 2 X Northern foundry, New York	19.75	19.00	14.25
No. 2 Northern foundry, Chicago	19.50	18.00	13.00
Bessemer, Pittsburgh	21.45	19.45	14.55
Basic, Pittsburgh	18.70	18.95	13.45
No. 2 X, Philadelphia	20.00	19.50	14.25
No. 2, Valley	18.50	18.50	13.00
No. 2 Southern, Cincinnati	17.90	17.40	12.40
Basic, Eastern Pennsylvania	19.50	18.50	13.50
Gray forge, Pittsburgh	18.45	18.10	13.45

Miscellaneous Metals—The present New York quotations in cents per pound, with a comparison of practically a month and year ago, are as follows:

	Jan. 21, 1916	Dec. 23, 1915	Jan. 22, 1915
Copper, electrolytic (carload lots)	24.50	21.00	14.00
Tin	41.62½	38.75	34.75
Lead	5.90	5.40	3.70
Spelter	19.00	18.00	6.75
Copper sheeets base	30.50	26.00	19.00
Copper wire (carload lots)	30.50	29.25	14.25
Brass rods, base	36.00	29.25	15.25
Brass pipe, base	40.00	34.00	14.25
Brass sheets	36.00	29.25	14.50
Solder ½ and ½ (case lots)	26.00	26.25	22.50

In St. Louis, lead sells at 5.77½ and spelter at 18.75. Lake copper in New York is quoted at 24.50c. cash and delivery is not promised until July.

Monel Metal—The following are the prices in cents per pound for mill lengths 8 ft. and over:

Size, In.	10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less Than 500 Lb. of a Size and Over
Rounds—Squares					
7/16 to 5/8	31.50	32.00	32.50	33.00	36.00
1/4 to 7/16	31.25	31.75	32.25	32.75	35.75
3/8 to 1 7/8	31.00	31.50	32.00	32.50	35.50
1 1/2 to 2 7/8	31.75	32.25	32.75	33.25	36.25
Rounds					
3 to 3 7/8	32.50	33.00	33.50	36.00	37.00
Squares					
3	32.50	33.00	33.50	36.00	37.00
Rounds					
3 1/2 to 3 1/2	32.25	32.75	33.25	35.75	36.75
Squares					
3 1/16 to 3 1/8	32.25	32.75	33.25	35.75	36.75
Rounds—Squares					
4 to 4 1/8	33.00	33.50	36.00	36.50	37.50
5 to 6 1/2	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ⅛ in. thick. Hexagon bars 2c. per lb. over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

Standard Pipe—On carload lots f.o.b. Pittsburgh, the discounts follow:

	Black		Galvanized	
	Jan. 21, 1916	Jan. 22, 1915	Jan. 21, 1916	Jan. 22, 1915
¾- to 2-in. steel butt welded	76%	81%	60½%	72½%
2½- to 6-in. steel lap welded	75%	80%	59½%	72½%

At these discounts, the net prices in cents per ft. follow:

Diameter, In.				
¾	2.76	2.20	4.54	3.15
1	4.08	3.24	6.72	4.67
1¼	5.44	4.38	9.09	6.30
1½	6.60	5.25	10.86	7.55
2	8.88	7.05	14.62	10.15
2¼	14.63	11.70	23.69	16.70
3	19.13	15.25	30.98	21.80
4	27.25	21.80	44.05	31.00
5	37.00	29.60	59.94	42.20
6	48.00	38.40	77.76	54.60

Cold Drawn Steel Shafting—From New York warehouse to consumers requiring fair-sized lots the price is 20% off list.

Sal Soda—These quotations are per 100 lb. at the places designated:

New York	$1.35
Philadelphia	1.10

Babbitt Metal—In New York, quotations are as follows in cents per pound:

Best grade	55@60
Commercial grade	25@30

Steel Sheets—The following are the prices in cents per pound from jobbers' warehouse, New York:

	Jan. 21, 1916	Dec. 23, 1915	Jan. 22, 1915
No. 28 black	3.50	3.15	2.60
No. 26 black	3.40	3.05	2.50
Nos. 22 and 24 black	3.35	3.00	2.45
Nos. 18 and 20 black	3.30	2.95	2.40
No. 16 black	3.45	2.90	2.34
No. 14 black	3.35	2.80	2.25
No. 12 black	3.30	2.70	2.20
No. 28 galvanized	5.50	5.25	3.50
No. 26 galvanized	5.20	4.95	3.20
No. 24 galvanized	5.05	4.80	3.05

Zinc Sheets—The following prices in cents per pound prevail at New York:

Carload lots, f.o.b. mill	23.00
In casks, New York	24.00
Broken lots, New York	25.00

Seamless Drawn Tubing—The base price per pound from New York warehouse is 37c. for brass and 37c. for copper. For immediate stock shipment 3c. is added, which gives the following quotations:

	Copper		Brass	
Diameter, In.	Jan. 21, 1916	Jan. 21, 1915	Jan. 21, 1916	Jan. 21, 1915
¾ to 2½	40.00	20.00	40.00	16.00
3	40.00	21.00	40.00	17.00
3½	41.00	21.50	41.50	17.50
4	42.00	22.00	42.50	18.00
4½	44.00	23.00	44.50	19.00
5	46.00	24.00	46.50	20.00
6	47.00	27.00	47.50	23.00
7	49.00	29.00	49.50	25.00
8	51.10	31.00	51.60	27.00

Old Metals—In New York, the following are the dealers' purchasing prices in cents per pound:

	Jan. 21, 1916	Dec. 23, 1915
Copper, heavy and crucible	19.00	16.75
Copper, heavy and wire	18.50	16.25
Copper, light and bottoms	16.50	14.25
Lead, heavy	4.75	4.50
Lead, tea	4.50	4.25
Brass, heavy	12.50	11.25
Brass, light	10.00	9.25
No. 1 yellow rod turnings	12.50	11.50
No. 1 red brass or composition turnings	12.00	11.00
Zinc	12.00	11.00

Coke—The following are prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Jan. 1	Jan. 8	Jan. 15	Jan. 22
Prompt furnace	$3.00@3.50	$3.25@3.50	$2.50	$3.00@3.25
Prompt foundry	3.50@4.00	3.50	3.75@4.00	3.50@4.00

Steel Shapes—The following prices in cents per pound are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger from jobbers' warehouse, New York:

	Jan. 21, 1916	Dec. 23, 1915	Jan. 22, 1915
Steel angles, base	2.50	2.40	1.85
Steel Ts, base	2.55	2.45	1.90
Machinery steel (bessemer)	2.50	2.40	1.80

Tin Plates—The following prices are in effect from warehouse, New York:

Coke tin plate, 14x20:

100-lb.	$4.45
I. C. 107-lb.	4.60

Terne plate, 20x28:

Base Weight	Net Weight	Coating	Price	Base Weight	Net Weight	Coating	Price
100-lb.	200	8	$8.30	I. C.	226	20	$13.50
I. C.	214	8	8.60	I. C.	231	25	14.25
I. X.	270	8	10.60	I. C.	236	30	15.50
I. C.	218	12	12.00	I. C.	241	35	17.00
I. C.	221	15	13.00	I. C.	246	40	19.00

Roll Sulphur in 360-lb. bbl. sells in New York at $2.15 per 100 lb.

Cotton Waste—In New York, the prices in cents per pound are as follows:

White	8.50@9.50
Colored mixed	6.50@8.00

Copper Rivets from warehouse, New York, sell at 35 and 5% off list and burs at the net list price.

Antimony—For Chinese and Japanese brands the quotation is nominal at 43c. per lb., duty paid.

Three-Inch Russian Shrapnel--III*

By John H. Van Deventer

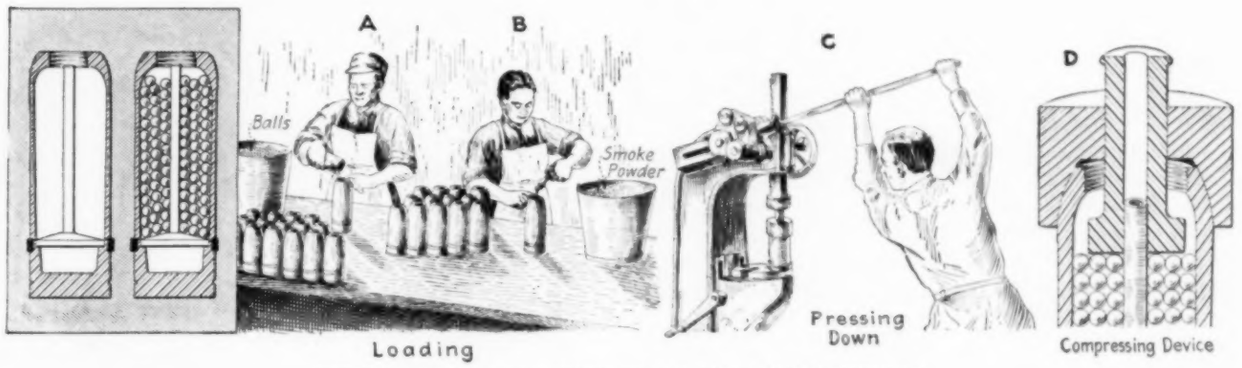
SYNOPSIS—A series of hand operations interrupting the sequence of machine operations on the three-inch Russian shells are described in this article. They include the loading with balls, the insertion of the fuse socket and copper plug and the filling of the shell with rosin.

With the exception of operation 13 the work on the Russian shrapnel described in the previous issues had to do only with the steel shell itself. The steel disk and powder tube in operation 13 added two other elements, which did not, however, materially affect the shop procedure as far as the projectile as a whole is concerned. At the seventeenth operation—that of loading or filling the shrapnel—which begins with this article, a number of elements are introduced which do have considerable effect on the further handling of the shell. Owing to the design and construction of these parts and the limitations of the requirements concerning them, it is no longer possible to handle the Russian shell mechanically, but its completion through the next six operations becomes an example of handwork pure and simple, quite a bit more so than in the case of the British shell of corresponding size, in which loading is a semimechanical proposition.

One of the causes for this difference is the fact that Russian specifications call for the insertion of "smoke powder" after five rows of balls are introduced into the shell. This composition is a mixture of metallic antimony and magnesium, the former producing dense black smoke and the latter a brilliant light, so that the explosion of the shell may be traced either by day or by night. The purpose of this smoke powder is to serve as a guide to the artillery observer who takes care of the range-finding, and of course has nothing to do with assisting in the explosion of the shell itself.

Russian shrapnel balls are cast from a mixture of four parts by weight of lead and one part by weight of antimony. The diameter of the balls is $\frac{5}{12}$ in., and the average weight of one is 6 drams. They are tested by being struck a slight blow with a hammer and must not crack under this test. A shell is supposed to contain from 256 to 265 balls, but in some cases in this country special provision reducing the number has been made by the inspectors, since the density of the metal employed made it impossible to get the full number of given-sized balls within the allotted space in the interior of the shell.

In order even to get the reduced number of balls into the shell, it is necessary to press them down by means of an arbor press, such as shown at *C* in operation 17. The first pressing down occurs after the smoke powder has been introduced, and in some cases a second and even a third pressing at certain stages of the filling are necessary in order to make the required weight. The tool shown at *D* in this operation sheet is used to facilitate this work. It consists of a plunger having a hole through its center, to admit the powder tube, and running in a guide the bottom of which conforms to the outside shape of the shell. Considering the restrictions and disadvantages under which this operation must be handled, three operators do well to produce 250 shells per hour.



OPERATION 17. LOAD WITH BALLS AND SMOKE POWDER

Machines Used—Hand operation with exception of arbor press C for pressing the balls into the shell.
Special Fixtures and Tools—Ball presser and guide D.
Gages—None.
Production—Three men and two arbor presses, 250 shells per hr.
Note—Five rows of balls are first inserted, then 13 drams 5 grains of a smoke powder composed of 55 parts of metallic antimony and 45 parts of magnesium.

The fuse socket of the Russian shrapnel is shown at *I* in operation sheet 18. It differs in many respects from the British shrapnel fuse socket, and most notably in the coarse pitch of the thread that receives the fuse. After the thread in the shell nose has been daubed with grease, as shown at *E*, the fuse socket is entered by hand; then the projectile is put upon a pair of scales so that the weight may be brought up to 13 lb. 5.6 oz., within the limit either way of the weight of one ball. Should the weight be found not sufficient, a ball is introduced, as shown at *H*, this process requiring considerable skill and manipulation. If the weight is excessive, there is nothing to do but remove the plug and take out a ball. It must be said that very few corrections need to be made, as experience soon teaches those who handle the assembling of shells to judge weight by "heft" almost as accurately as scales will measure it.

One of the most essential precautions in hand assembling is to make sure that the powder tube has not been distorted or crimped or otherwise injured. Therefore as

*Previous installments appeared on pages 89 and 155.

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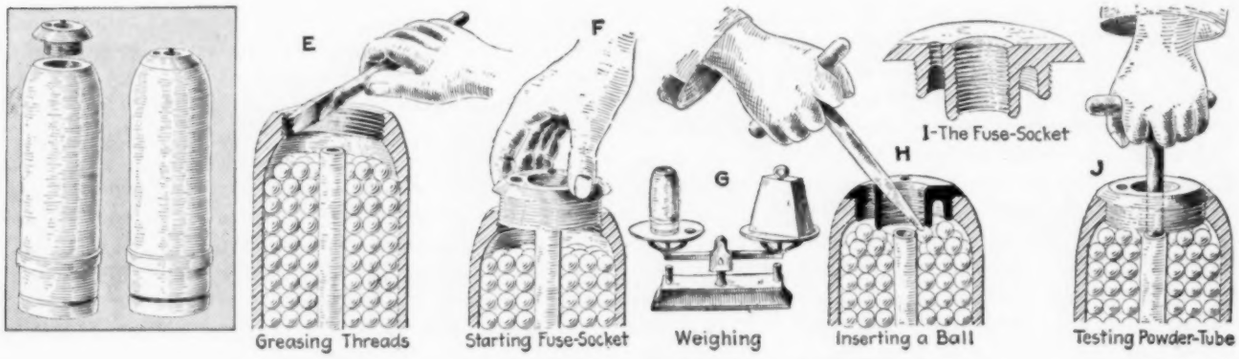
soon as the weight has been found to be correct, a rod gage is run down through the powder tube. It must go all the way to the bottom of the powder pocket. This gage consists simply of a tool-steel rod of a diameter equal to that of the interior of the tube and provided with a handle at the top, such as is shown at *J* in operation sheet 18. After the weight of the loaded shell and the condition of the powder tube have been found to be correct, the fuse socket is screwed down. This process is like the operation of a miniature treadmill and is shown in operation sheet 19. The shell is held securely in a hinged vise mounted upon a pedestal, and the socket is driven home through the exertions of an operator who walks backward in a circle, pulling the pipe extension handle after him. One feature of this operation is the wrench used, which is a screw plug wrench conforming to the thread of the fuse socket and having an extension pilot that projects into and protects the central powder tube.

A difference in design between the British and the Russian shrapnel is noticed in the means used for sealing the upper end of the powder tube to the fuse socket. In the British shell the brass powder tube was soldered direct to the bronze fuse socket after the loading was completed. In the Russian shrapnel the joint is made by means of a copper plug, shown at *K* in operation sheet 20, which screws down within the fuse socket and has a recessed central hole that fits over the central powder tube. No solder is employed to make this joint, but the plug is screwed down in such a way that the powder tube is securely held. For this purpose a wrench, shown at *L*, is employed. It is quite similar in principle to that used in operation 19, for screwing down fuse sockets, except that it has a screw-slot key projection instead of threads.

Since this joint is not made tight with solder or other packing, it is essential to seat the copper plug squarely against the tube. This is tested by means of a gage, shown at *Q*, which has a double purpose—first, to indicate whether the copper plug has been screwed down the correct distance; and second, to show whether it is squarely seated. This latter test might seem unnecessary, but is called for because the threads on the copper plugs are not always accurately or squarely cut.

A box of apothecary's corks appears to be rather out of place in a shrapnel-manufacturing plant, but starting with this operation its contents become very useful. A cork is inserted in the powder tube of each shell and remains there during the succeeding operations as an insurance against the entrance of dirt or other foreign material. Just before the fuse-hole plugs are inserted, these corks are withdrawn and returned to the bench at which this operation is performed, to be used over again.



OPERATION 18. START FUSE SOCKET AND MAKE WEIGHT

Machines Used—Hand operations.
Special Fixtures and Tools—Brush E for smearing grease in threads; drift H for inserting balls.
Gages—Scales G for weight; rod J for testing powder tube.
Production—Three men take care of 250 shells per hour.
Note—Weight at this operation is held to 13 lb. 5.6 oz. plus or minus the weight of one of the small lead balls.

OPERATION 19. SCREW DOWN FUSE SOCKET

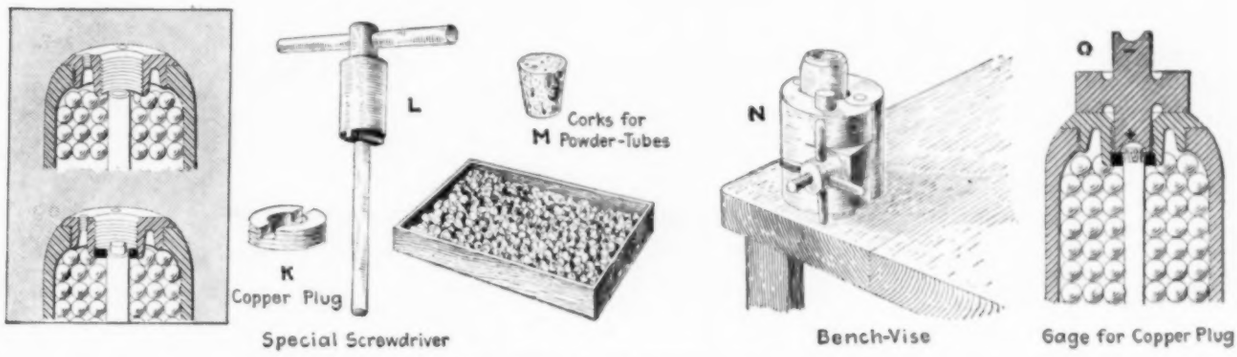
Machines Used—Hand operation.
Special Fixtures and Tools—Hinged chuck vise mounted on pedestal; double-ended screw-plug wrench with guide to fit powder pocket.
Gages—None.
Production—One man screws down from 40 to 60 sockets per hour.
Note—The production rate is variable, caused by the variation of threads on the fuse sockets as received.

At this stage one is apt to question how the shell is to be filled with rosin, since all openings available for this purpose seem to have been closed by the insertion of the fuse socket and copper plug. However, this filling is taken care of by two small holes, shown at *A* and *B* in suboperation *P* on operation sheet 21. The larger hole

is for the admission of melted rosin, and the smaller one for the escape of air.

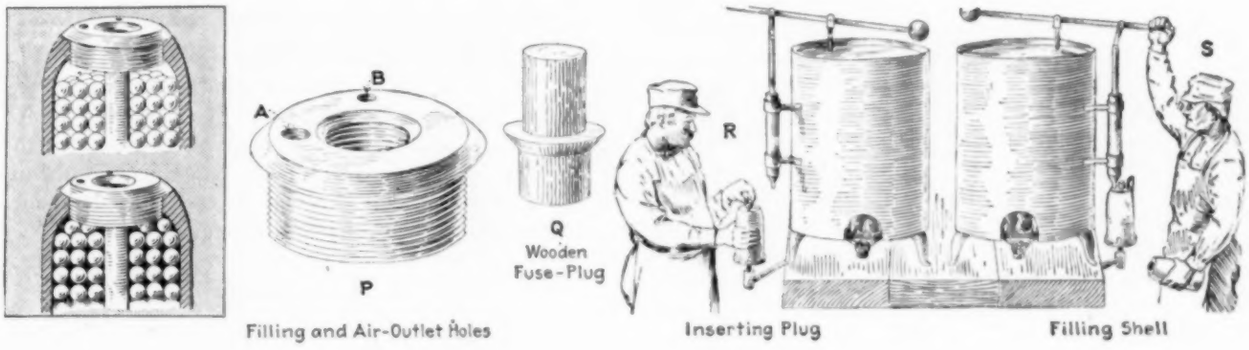
In order to introduce the rosin through such a small opening as has been left for it, a force pump is provided on the side of the rosin kettle, as shown at *R* in this operation sheet. The nose, or discharge opening, of this force pump is made to fit inside of the hole *A* in the fuse socket. One stroke downward of the pump lever fills the shell with rosin and causes a little to flow over, which

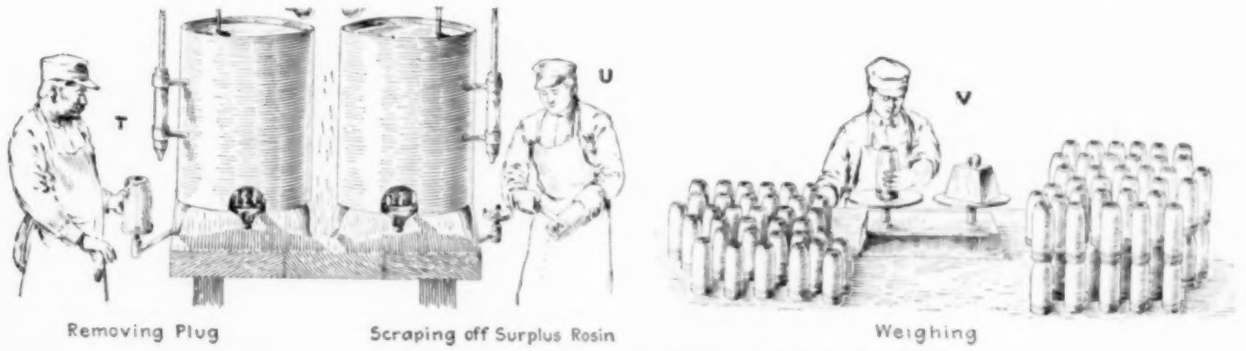
It is necessary to remove the few drops of rosin which overflow through the air outlet, and this is done by means of one or two passes of a hand scraper, as shown at *N* in this operation sheet. Next, the shell is placed upon a pair of scales to determine its weight. One advantage of the Russian method of filling shells with rosin is the fact that the operator does not need to exercise an unusual degree of haste in entering and screwing down the fuse socket before the rosin becomes solidified. In the British



OPERATION 20. INSERT COPPER PLUGS AND CORKS AND TEST COPPER-PLUG SEATING

Machines Used—Hand operations.
Special Fixtures and Tools—Special plug screwdriver L, with pilot extension to fit powder tube; hinged chuck N used as a bench vise in order to provide ample holding power.
Gages—Limit snap gage O, to test depth and squareness of copper-plug seating.
Production—Two men handle from 175 to 250 shells per hour.
Note—Variations in the threads varies production rate.





OPERATION 21. FILL WITH ROSIN AND WEIGH

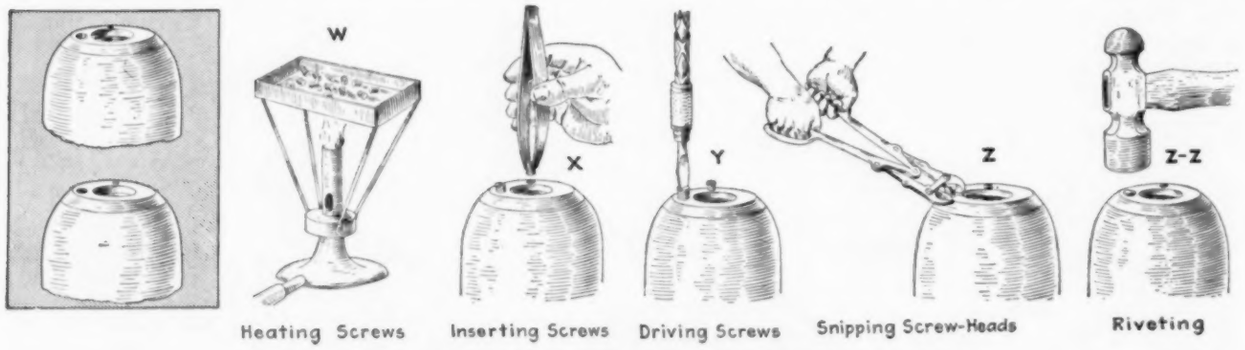
Machines Used—Hand operations.
Special Fixtures and Tools—Wooden plugs Q for fuse sockets; rosin kettles R and S, fitted with force pumps.
Gages—Scales for checking weight, shown at V.
Production—One operator at each kettle can produce 50 to 60 loaded shells per hour.
Note—The rosin kettles are gas-fired and are provided with handy tapping device.

is necessary to indicate that the shell is completely filled. The rosin is prevented from entering the threads by means of wooden plugs, such as shown at *Q*, which fill up the thread nose and prevent the necessity of cleaning out these threads later on. The rosin kettles are heated by means of gas burners and are arranged to be supplied from above by means of a rosin storage supply.

shell it is important that this be done, and the necessity of doing so in a hurry does not add to the convenience of the operation.

The next step following the filling of the shell with rosin consists in plugging the rosin-admission and air-outlet holes, this work being shown in operation sheet 22. The screws used in plugging these holes are kept at a

blue heat by means of the apparatus shown at *W*, it being necessary to have them at this temperature in order that they may melt whatever rosin remains in these two holes and thus clear the way for themselves without the necessity of cleaning the holes out otherwise. An operator becomes quite expert at handling these hot screws, having a pair of tweezers as an aid in starting them. They are driven home by means of a Yankee screwdriver, after which the protruding heads are snipped off with a pair of hand snips, and whatever remains is riveted down with a hammer. This operation completely seals up the interior of the shell and its contents of balls and smoke powder, leaving an opening, however, to the powder pocket through the central powder tube, which has been and is still during this operation closed with a cork.



OPERATION 22. INSERT PLUGGING SCREWS, SNIP HEADS AND RIVET

Machines Used—Hand operations.
Special Fixtures and Tools—Heating pan and gas burner W; tweezer pliers X; Yankee screwdriver Y; hand snips Z.
Gages—None.
Production—Two men insert screws, screw down, snip heads and rivet 250 shells per hour.

There are a number of checks upon the proper filling of the Russian shell. One of these is the weight of the complete shell, which indicates whether it contains the required number of balls. In addition to this a certain number of shells are unloaded or disassembled, the inspector having the right to disassemble not over one-half of one per cent. of the entire number of finished shells. Sometimes instead of disassembling a shell, a section is sawed out longitudinally upon a milling machine, exhibiting the cross-section of the interior of the shell and showing the regularity of loading. Points that are observed or looked for in these examinations are as follows: The proper fastening of the fuse socket to the body of the shell; the correct seating of the upper end of the powder tube into the copper plug; the regularity of the powder tube, and whether it has been mashed through loading; the proper filling of rosin and smoke powder; the position of the diaphragm in its seat, and whether the proper number of balls has been inserted. This latter point is established by the actual count of the contents of the disassembled shrapnel.

The hand operations do not lend themselves to that strict regulation that is possible with machine operations, especially on a product which has been manufactured for such a short time that a balance of skill, as it might be called, has not been established. Hand operations are always more difficult to bring to a point of relatively high efficiency than are machine operations. It is here that the greatest fluctuations in production rate take place, but there is one compensation to offset this—it is much easier to add men than it is to add machines, and such fluctuations therefore, although they may throw the production slightly out of balance, are quickly and easily corrected. It is quite possible, however, to conceive of a shrapnel so designed that hand operations as such could be almost entirely eliminated and their place taken by machine operations. When such a shell is designed, it will eliminate many of the harder problems that are now encountered by those making projectiles of English and Russian design. Those who are now working on war contracts, however, must take things as they find them and make the best of conditions that cannot be bettered.

Chart to Determine Maximum Unit Repeated Stress

By J. B. Kommers*

At the meeting this year of the American Society for Testing Materials, H. F. Moore and F. B. Seely, of the University of Illinois, presented a paper on "The Failure of Materials Under Repeated Stress." In this paper they derived the two following formulas:

$$S = \frac{B}{(1 - Q)\,N^{\frac{1}{4}}} \qquad (1)$$

$$S = \frac{B}{(1 - Q)\,N^{\frac{1}{4}}}\,(1 + 0.015\,N^{\frac{1}{4}}) \qquad (2)$$

where

S = Maximum applied unit stress;
B = A constant depending upon the kind of material;
Q = The ratio of minimum unit stress to maximum unit stress (Q becomes negative when the stress is reversed);
N = The number of cycles of stress that will cause failure.

Formula (1) is to be used for structural parts and machine members when failure would endanger life; formula (2) is to be used when failure would not endanger life.

The alignment chart on the following page has been plotted for formula (2).

The paper gives the following tentative values of B for the common metals:

Material	Values of B
Structural steel and soft machinery steel	110,000
Cold-rolled steel shafting	275,000
Steel, 0.45 per cent. carbon	175,000
Wrought iron	100,000
Hard steel	250,000
Hard steel wire	400,000

*Assistant professor of applied mechanics, University of Wisconsin.

NUMBER OF CYCLES OF STRESS
VALUES OF Q, THE RATIO OF MINIMUM UNIT STRESS TO MAXIMUM UNIT STRESS
UNIT STRESS IN POUNDS PER SQUARE INCH
VALUES OF B, A FACTOR DEPENDING UPON MATERIAL
KEY DIAGRAM
Explanation
Connect the points on the B and Q scales, corresponding with the given values of B and Q, and note the intersection of the connecting line and the Y axis. Connect this intersection and the point on the N scale corresponding to the given number of cycles of stress. At the point where this line cuts the S scale read the unit stress that will cause failure
The example solved in the key diagram is for B=100,000, Q=0, and N=10,000,000. The corresponding maximum unit stress, S, is 14,800 pounds per square inch.

CHART TO DETERMINE MAXIMUM UNIT REPEATED STRESS—BY J. B. KOMMERS

Welding Pipe Parts with the Oxyacetylene Torch

The Prest-O-Lite Co., Indianapolis, Ind., employs the oxyacetylene torch extensively for welding and cutting operations on a wide variety of sheet-steel work.

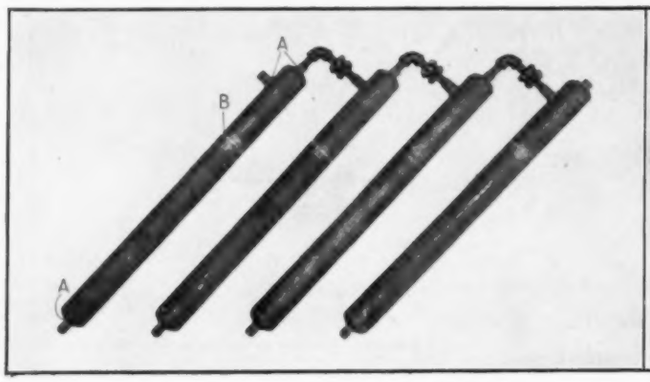


FIG. 1. A WELDED OIL SEPARATOR

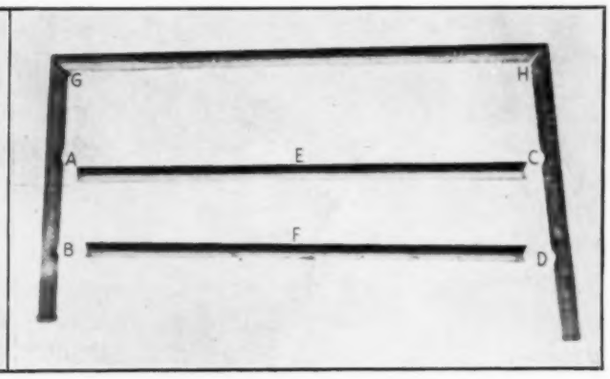


FIG. 2. THE PIPES AS PREPARED

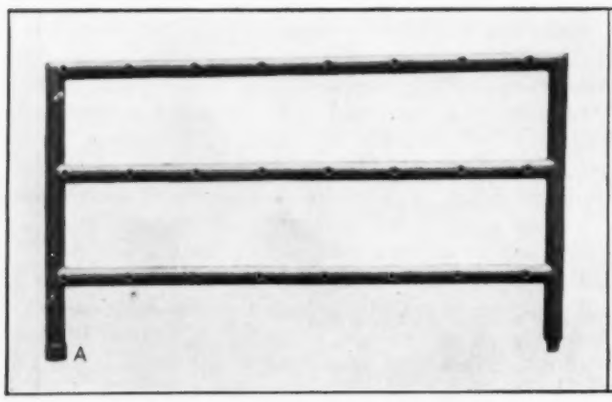


FIG. 3. THE FINISHED DISTRIBUTOR

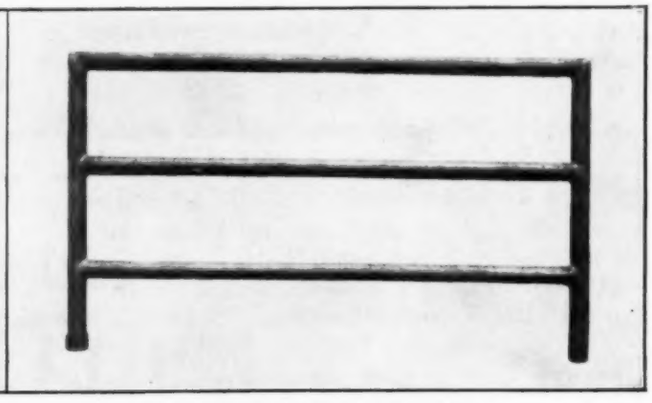


FIG. 4. THE PIPES AS WELDED

In Fig. 1 is shown an oil separator which has been manufactured by the use of the welding torch. The separator is 4 in. in diameter by 45 in. long, and the walls are $\frac{3}{16}$ in. thick. Three nipples, two for $\frac{3}{4}$-in. pipe and one for $\frac{1}{2}$-in. pipe, are welded on the separator at *A*. The two parts of the separator body are also welded at *B*.

The different welded elements are then fastened together with couplings until the required number is obtained. When making one of these elements, 25 in. of welding is made, and the time required is $\frac{1}{2}$ hr. The approximate amount of gas needed is 22 cu.ft. each of oxygen and acetylene.

The next example is the welding of a meter distributor. The work was done in California, the torch used being one manufactured by the Prest-O-Lite Co.

This distributor is made from 4-in. piping and tees. After the piping has been cut to the correct lengths, holes are made with the torch at *A*, *B*, *C* and *D* to suit the ends of the pipes *E* and *F*. The piping is then welded at the corners and at the cross pipes *E* and *F*.

The finished welded distributor is shown in Fig. 3. It will be seen that one end *A* has a threaded union fastened to it. This is used for connecting to the service from the street piping.

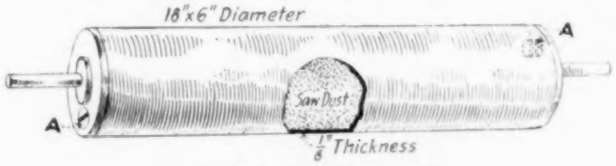
The part then assumes the shape shown in Fig. 4. Openings are cut with the torch in the cross pipes, and sockets with the desired size of outlets are welded in place.

When welding the main joints one hour's time was occupied and 25 cu.ft. of each gas—oxygen and acetylene—was used. For the 25 small joints two hours' time was taken and 50 ft. of each gas consumed. When performing the cutting operations, 45 min. was required and 30 cu.ft. of oxygen and 10 cu.ft. of acetylene.

A Simple Turning Kink

By Harold E. Green

The roll shown in the sketch is an ink roll that is used in a paper-bag machine. It is made of brass pipe with the heads forced in, after which a truing cut is taken



A SIMPLE TURNING KINK

across it. It is so light that no matter how the turning tool is ground, it will chatter.

To obviate this, I drilled and tapped a hole in each end *A* for a pipe plug and then filled the roll with sawdust, which added enough weight so that the job was done satisfactorily, the sawdust then being let out.

Painting Small-Shop Products--I

By John H. Van Deventer

SYNOPSIS—This article is one of a number that will deal with methods of painting and finishing products made in the small shop. In this issue the desirability of good finish is described, and points are given on the selection of colors and the preparation of castings.

"If you wish to enjoy a funny show at the theater, don't let an optimist tell you about it in advance."

Dave Hope was responsible for this bit of wisdom, and said that it is human nature to like an agreeable surprise not only in matters of pleasure, but also in business. Rather a funny way for him to answer my question about painting and finishing small-shop products, I thought at first, but changed my mind after he went a bit farther into the matter and related a personal experience.

"Did you ever have a real swell salesman call on you," he asked, laying aside his surface gage; "one of the kind that wears patent-leather shoes and gray spats, fuzzy green hats and diamond scarf-pins?

"About a month ago I was in the market for a new machine, and one of these birds flew in to answer my inquiry. He didn't have to announce himself, for his clothes were loud enough to speak for themselves. Before I had time to recover from the shock, he pulled out a leather cigar case, offered me a Ruy Elegancia and insisted that I take dinner with him at the Castor House.

An Elaborate Catalog in Embossed Leather

"After we had eaten about four dollars' worth, and the waiter had made off with the remains of the fivespot, my fancy friend got down to business. He pulled out an elaborate catalog bound in embossed leather and began to show me the pictures. First was a bird's-eye view of the factory, and over the page a front elevation of the executive offices, with gardens and automobiles attractively arranged in the foreground. On another page was the interior of the president's private office, done in mahogany with tapestry hangings. After I had sufficiently admired this elegance, he turned to the secretary's sanctum, the stenographer's studio and the directors' room. Next he called attention to the designing department and engineering office, each the last word in finish and equipment. Coming to the factory, he pointed out the recreation and lunch rooms and also the first-aid department, with its white-enameled furniture and its white-upholstered attendants. A few more pages brought us to the chemical and physical laboratories, with bottles and test-tubes and ovens and thermometers arranged for 100 per cent. efficiency. Next came some elegant views of the foundry and various shop departments, the latter having individual motor drive and electric transportation trucks.

"Finally we got to the last part of the book, where it said a few words about what they made in the plant; but the poor fellow was all tired out by this time, so that I had to pick out the machine I wanted and sell it to myself.

"Two days later I received an engraved card thanking me for the order and promising shipment within three weeks. Ten days after that the shipping bill arrived, and along with it was a book of instructions about operating and taking care of the machine. That book was a work of art, printed in three colors and containing some of the slickest pictures you ever saw. Mrs. Hope made me keep it on the parlor table.

"I could hardly wait to get the machine from the freight house and rip off the crate and packing paper to see the slick piece of work that such an uptodate and enterprising firm must have produced.

Feeling Like a Nickel's Worth of Radium

"Say, you could have swapped me for a nickel's worth of radium when I saw that machine. Foundry sand was sticking to it here and there; and from the looks of the sloppy single coat of machine-gray paint, a bush-league painter's apprentice must have thrown a brushful of paint at the thing from center field, and almost missed the mark at that.

"I wrote a letter to the firm, asking them if that was the regular finish on their machine, and this is what I got in reply," exclaimed Dave, fishing a letter out of his pocket:

> Dear Sir—In reply to yours of Jan. 6, with reference to the finish on machine shipped on your order No. 776 beg to state that this is our regular finish.
>
> Our policy in this respect is to embody the highest mechanical skill in building these machines; and since fancy painting will not make it operate any better we prefer not to sacrifice quality for looks and therefore keep down expense on this less important feature. Yours very truly,
>
> BLANK MACHINE WORKS.

"And here is my reply," said Dave, handing me the following letter:

> Gentlemen—I have noted what you say with regard to finishing your machines.
>
> I am not a stickler for style, but if a man whom I know to be in comfortable circumstances pays a call at my house dressed like a dilapidated hobo, with dirty face and hands, he won't get any farther than the kitchen steps, no matter how many engraved advance calling cards he has sent me.
>
> I take as much pride in my shop as I do in my home; and while your machine has good working qualities, its poor finish has caused me to install it in a dark corner where I hope no visitors will see it. Yours very truly,
>
> DAVID HOPE.

Efficiency Has Not Eliminated Human Nature

A few large shops have built up purchasing organizations that can lay aside all thought of anything except the ultimate dividend-earning capacity of a proposed purchase. They don't care whether a machine is pink, green yellow or black, as long as it will operate with a certain guaranteed efficiency on a certain product for a certain number of days in the year. Those who build things that are bought only by such concerns do not need to add fine finish as a selling point. But remember, where there is one purchaser who comes in this class, there are nine hundred and ninety-nine others not so far advanced, who look upon the purchase of each machine as a red-letter event—something to be thought about a long time in advance and admired for a long while afterward. Give a man of this type an article that he can be proud to show as well as to use, and he will go out of his way to boost it.

Science has done a good deal during the past few years, but it hasn't succeeded as yet in making a silk purse out

of a sow's ear nor a well-finished machine—a durably finished one—from poor castings. Holes can be plugged with filler, and foundry sand covered with pigment until the surface is perfect to all appearances; but by and by a spot will scale off here and there, taking with it as many coats as have been applied and transforming an attractive machine into an imitation of a mangy dog.

The small-shop man as a rule buys his castings and is thus in a good position to pick and choose, much better than the man who operates his own foundry and who is tempted to use anything therein made that has a faint resemblance to the original pattern. In buying castings, usually from a large jobbing foundry, it is possible to insist upon and to get good, clean, smooth castings. If the people you deal with can't give you satisfactory castings at the right price, try someone else—sticking to one thing isn't always a virtue, as the fly remarked to the fly-paper. Therefore if you are aiming at quality finish, make sure of a fair start toward it in the matter of castings and have them sand-blasted.

Sand-blasting makes the best surface for paint or enamel that can be had. The small shop with a sand-blast apparatus is an exception, and I should not advise installing one in such a shop unless conditions are quite unusual and there are a number of other profitable uses for compressed air. But the jobbing foundry of any size that has no sand-blast apparatus is also an exception, and thus the small-shop man may have sand-blast cleaned castings if he calls for them.

Getting Pickled Has Its Disadvantage

Some shops get clean castings by pickling them in an acid dip. The solution that is most commonly used for cast iron is one part of the commercial sulphuric acid to eight parts of water. Pickling will remove the scale and sand, but has the disadvantage that some of the solution may remain in the pores of the casting, resulting in the painted surface flaking off in such places. It is not enough to wash the pickled casting in water if this catastrophe is to be prevented; the acid must be neutralized by an alkaline solution such as sal soda dissolved in water in the proportion of ½ lb. to the gallon, preferably kept and applied hot. This in turn must be washed from the piece with water, alkali not being any more friendly toward paint than it is toward oil or grease or acids.

Assuming that the small-shop man has by hook or crook, luck, sand-blast or pickle secured a fair start toward a fine finish by getting smooth, clean material, what further steps he must take will depend on whether he is going to brush, dip or spray; whether the finish is to be dull, semi-gloss or full gloss; whether it is to be air dried or baked, and somewhat upon the color.

Color Affects the Sale of Machines

Color is a more important thing than a great many imagine, as applied to machine finishing. A pea-green lathe or a bright-yellow miller would have small chance of leaving a jobber's display floor, whereas these same bright colors are favorable to disposing of hand pumps and farm tools. Black is the color of dignity; the machine shop must be a dignified place, judging by the color of its equipment—if you find it too oppressive, take a walk into the engine room and have a look at the frivolous red engine.

The choice of color that will make an article salable is far from being simply a matter of good taste. It really calls for a mixture of genius and a deep knowledge of psychology, diluted with considerable good luck. It is easier to tell what not to do in this matter than to say what should be done. For one thing, do not depart too widely from what has been more or less accepted as general practice for the product. Make it similar, but better. A pioneer in the choice of colors has a hard row to hoe. When in doubt, paint it black, for this color in paint as well as in clothes is suitable for all occasions.

Green and Yellow Bringing Home the Bacon

The painting of articles for export is an art in itself, especially where the goods go to tropical countries. This is not because of the difficulty in getting a finish that will stand the heat, but of getting one that will suit the natives. Having at various times been connected with two factories making quite different lines of mechanical goods, both of which had large sales in South America, I am in position to pass out a bit of advice that is the result of observation. If you make machines for this trade, paint them bright green with yellow stripes and decorate the larger surfaces liberally with florid transfers; then you are sure to make a killing. This may sound like a joke, and in fact the machine thus treated looks like one; but notwithstanding this, green and yellow will bring home the bacon from South America.

The choice between dull finish, semi-gloss and full gloss is not as difficult as that of the proper color. Size has a good deal to do with this. A large machine or surface looks better with the dull finish, largely because this tones down all large irregularities or waves which cannot be corrected by applying filler. Semi-gloss, or eggshell, finish, while taking considerable skill to apply properly, is effective for medium-sized machines where cast iron is the main material, and has the advantage of not showing splotches of oil. Full gloss, or enamel, finish is most effective on small articles such as may be made part of a machinery jobber's window display; when well executed, this finish will help to attract the eye of a possible customer.

Fine Finish Must Be Consistent

To be really fine, the finish selected must be consistent with the use of the machine or part, in other words must serve some purpose aside from mere decoration. It is disappointing, to say the least, to buy an engine or pump attractively painted and then have its color darken and turn dead and muddy when the thing is subjected to its working heat. Nor is it altogether pleasing to have a tool that is meant to be handled shed its coat like a locust. Japan and baked enamel finishes have reasons for use other than to simply give the article a shiny appearance. Resistance to heat and resistance to handling are among the reasons for the employment of these more durable finishes, which, it will be found, are not beyond the reach even of small shops.

Protection against rust is one reason for painting those parts of machines that do not show—here the ornamental side is forgotten altogether and the purpose becomes strictly utilitarian. The interior of oil chambers of bearings are painted with another purpose in view—to keep sand from the cast surfaces from dropping into the oil and thus damaging the bearing. A paint made of red lead and linseed oil is best for this purpose, not being softened by lubricating oils.

Machine-Forged Beading Tools*

By J. C. Breckenridge†

The evolution of a beading tool as made in an Ajax forging machine is as follows: First, flattening; second, punching; third, forming; fourth, grinding off fins,

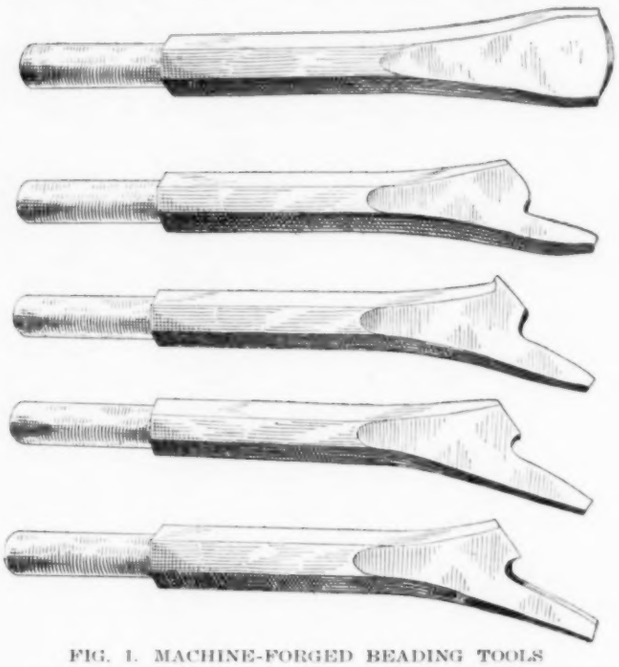


FIG. 1. MACHINE-FORGED BEADING TOOLS

and rounding off edges with file; fifth, hardening and tempering. As it is made from ⅞-in. octagon steel, the upsetting of the steel with its resulting evils is entirely avoided.

The hardening of the tools is accomplished with an oil-burning tool furnace and a pyrometer to register the proper hardening temperature. In drawing the temper, an oil-tempering bath with an indicating thermometer is used. The tools are handled in lots of 500 at a cost of 25c. per tool. The average amount of service from a beading tool is 4,000 flues beaded before it has to be re-formed. The forging-machine dies are made from ma-

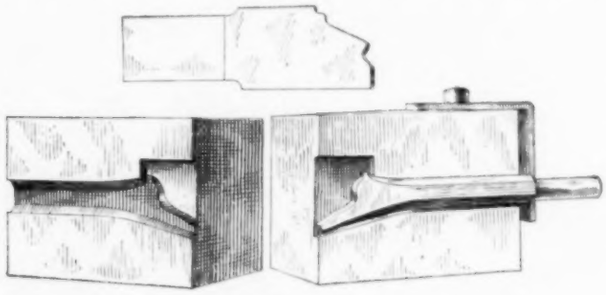


FIG. 2. DIES FOR BEADING TOOLS

chinery steel with vanadium-alloy tool-steel inserts at a total cost of $50.

The success of this tool is chiefly due to the methods employed in its manufacture. It is made from annealed low-carbon tool steel. The blanks are first cut to length from the stock bars in a power shear, four blanks being cut off at each stroke. The round shank end, $\frac{11}{16}$ in. in diameter, 2½ in. in length, is next turned in a lathe with the aid of box tools. The blanks are taken to the forge shop and heated in an oil-burning furnace and formed in a 2-in. Ajax forging machine. The illustrations make the work clear.

*From "Proceedings," American Railway Tool Foremen's Association.

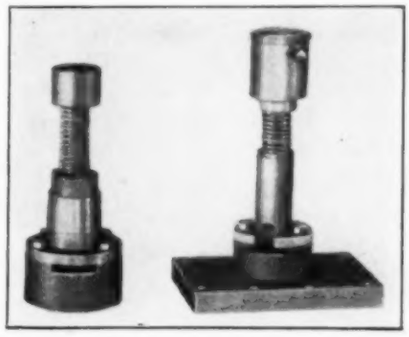
†Supervisor of tools, Frisco Railway.

Making Fiber Washers

By E. V. Allen

The illustration shows two tools used in the shop of the F. W. Lindgren Co., Rockford, Ill., for cutting out fiber thrust washers. They are used in a common mandrel press, and a boy can easily run out several hundred in a short time.

The tool at the left blanks the washer out of a strip of fiber sheared to the proper width. It also pierces the



MAKING FIBER WASHER

center hole of the washers, which are thrust into it one at a time against a stop and then pushed out from the back. The bases of these tools, or dies, are made of cast-iron scrap pieces. The dies, plungers and guides are made from scrap steel. Each plunger or punch is shouldered at the upper end, so that a spring may be placed on it to force it upward as the press ram releases it.

Grinding-Operation Kink for Hardened Rollers

By W. L. Conklin

A small job that I had to do recently in a grinder may be of interest to some readers.

The work consisted of five tool-steel rollers, $\frac{3}{16}$ in. in diameter by $1\frac{3}{8}$ in. long, with as small a center as possible in each end. They were to be hardened and ground. This seemed all right until I tried to decide upon the way to drive the rollers so that a cut clear across the face could be taken.

I put the hardened roller on the centers of a cutter grinder, locked the head center so that it would rotate with the work, then placed the tailstock center in position. Before starting, I regulated the tension of the compensating tailstock spring with a wooden wedge placed between the center release latch and the frame of the tailstock so that enough pressure could be got on the center to hold the work steady and yet allow it to rotate very freely. After this adjustment a soldering iron was used to put a small amount of solder on the head center close up to the face of the roller. By this means the work was locked tight enough to allow the grinding of the rollers to the finished size.

Machining Exhaust Manifold and Details of V-Motor

By Robert Mawson

SYNOPSIS—In this article is shown the fixture used in milling the exhaust manifold. For machining the front bearing housing, two milling and one drilling operation are described. The rocker arm has a multiple milling operation and a simple drill jig. Two indexing jigs are used in machining the cylinder, other tools for which were shown in a previous operation. These tools represent advanced ideas in tool designing and manufacture.

On page 19 was shown and described the Ferro eight-V-motor manufactured by the Ferro Machine and Foundry Co., Cleveland, Ohio. This motor is of a novel construction employing a single casting which takes the place of the upper crank case and cylinder casting. The gas operating mechanism, the motor being of the valve-in-the-head type is carried in a separate casting attached to the cylinder being known as the cylinder head.

Over the head is fastened the cover the function of which is to hold the spark plugs. A light pressed steel stamping is used for the oil pan or lower crank case. On pages 14 and 98 are shown some of the special small tools used in manufacturing the motor. It will be observed that these tools illustrated the latest types of jig and fixture design and the times required for performing the machining operations, speeds and feeds, of cutters and other data are included. In this article are described the tools used when machining three other smaller elements used on the motor. It will be seen that these illustrations, as well as those given in the previous article, represent high-grade jig and fixture design and construction working out satisfactorily under commercial conditions.

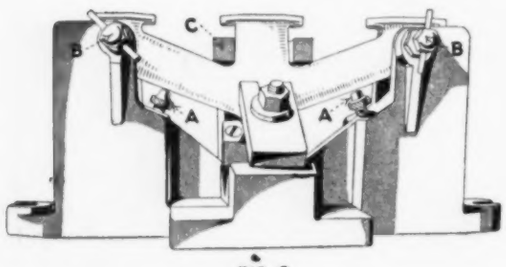
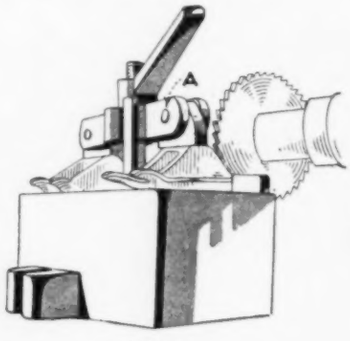


FIG. 2



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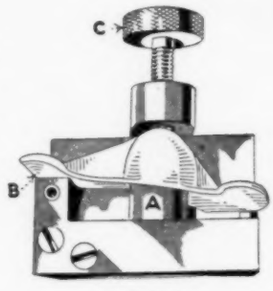


FIG. 5

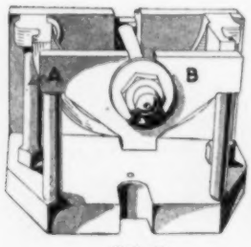


FIG. 7

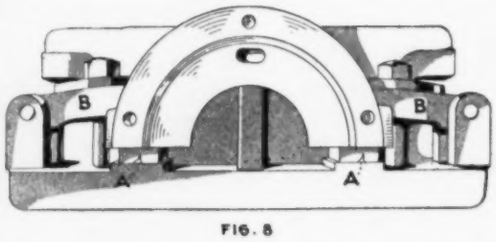


FIG. 8

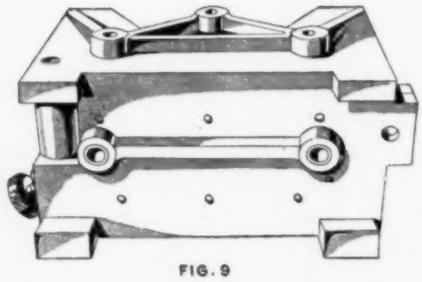


FIG. 9

JIGS AND FIXTURES USED IN MACHINING V-MOTOR DETAILS, WITH WORK IN POSITION

FIGS. 2 AND 2-A

Operation—Milling exhaust manifold, Fig. 1. Casting is located in steel V-block and knurled-head screws A are tightened against it; screws B and strap C are tightened to hold it securely.

Surface Machined—Joint surfaces, using 4-in. end mill; speed, 76 r.p.m.; feed, 0.083 in. per revolution.

FIGS. 4 AND 4-A

Operation—Milling slot in valve rocker arm, Fig. 3. Forgings are located on finished plugs, which rest in machined recess. Clamps A are operated by a handle and hold down four pieces at one setting.

Surface Machined—Notch, using 4-in. diameter by $\frac{5}{16}$-in. thick cutter; speed, 85 r.p.m.; feed, 0.03 in. per revolution.

FIGS. 5 AND 5-A

Operation—Drilling hole in rocker arm. Forging is located on plug A and fin B, which is set in slot of jig. Knurled-head screw C holds it in position.

Hole Machined—No. 48 hole through web.

FIGS. 7 AND 7-A

Operation—Milling parting line of front bearing housing, Fig. 6. Rough casting is placed on two pins as A and held in position with strap B.

Surface Machined—Joint surface, using 5-in. cutter; speed, 62 r.p.m.; feed, 0.015 in. per revolution.

FIGS. 8 AND 8-A

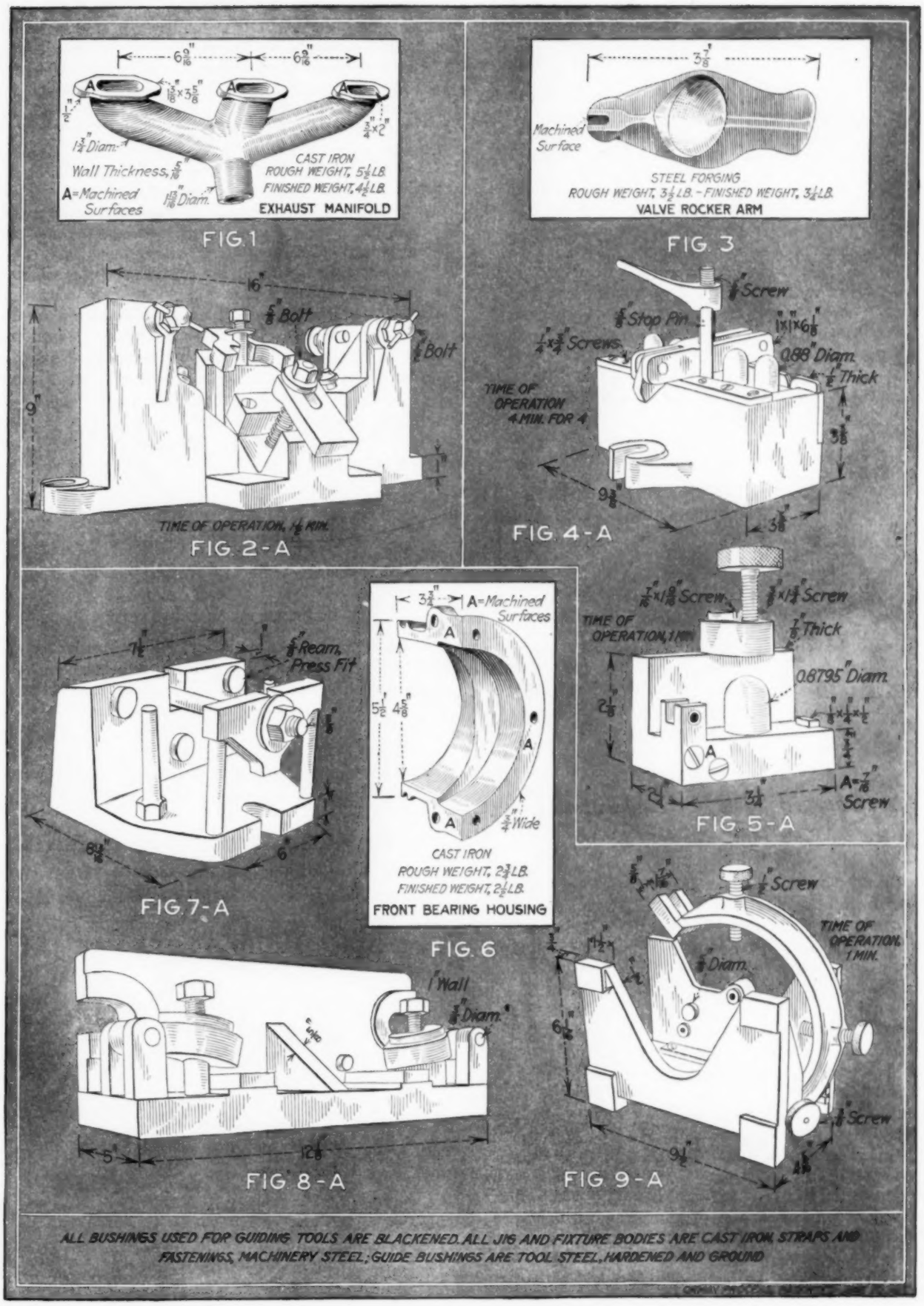
Operation—Milling face of front bearing housing. Casting is located on two hardened-steel pads A and is held down with straps B.

Surface Machined—Front face, using 3-in. end mill; speed, 100 r.p.m.; feed, 0.03 in. per revolution.

FIGS. 9 AND 9-A

Operations—Drilling holes on face and bolt holes in front bearing housing. Casting is placed on steel pads and the cover dropped down and fastened with knurled-head screw, two screws holding it in position.

Holes Machined—Three $\frac{1}{4}$-in. in face and two $\frac{11}{16}$-in. for joint bolts. The three $\frac{1}{4}$-in. holes are later tapped with $\frac{5}{16}$-in. 18 U. S. F. threads.

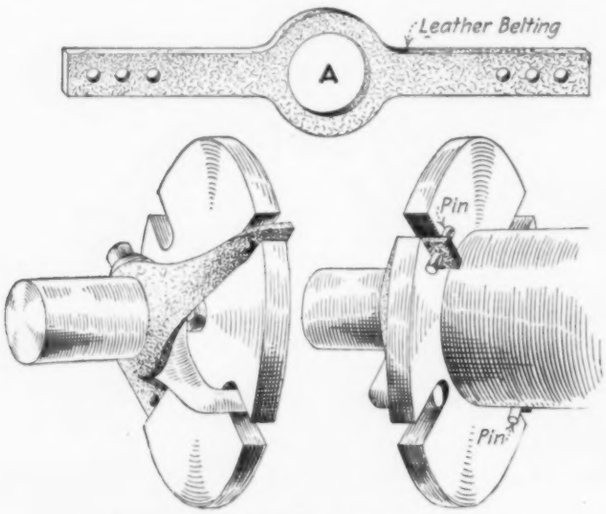


DETAILS OF JIGS AND FIXTURES USED IN MACHINING EIGHT V-MOTOR PARTS

Device To Hold Center Work to Faceplate of Lathe

By William C. Betz

We had a lot of spindles to be steadyrested for boring, and one of the boys devised a leather strap, *A* in the illustration. To use this strap, the lathe faceplate is backed away from the spindle shoulder about four threads, as when using a belt lace. The strap is put on the piece to be machined and a lathe dog fastened in place. The strap



SPECIAL STRAP FOR CENTER WORK

ends are then slipped through the driver slots, brought up tight and pins slipped through the holes, as shown. The faceplate is screwed back against the spindle shoulder, which brings the work tight against the headstock center.

This strap is much more convenient to use than the belt lace.

Dies for the Manufacture of Piston-Rod Nuts*

By B. Henrickson†

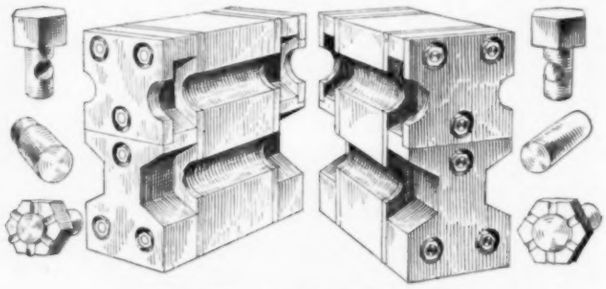
On all its new and heavy power the Chicago & Northwestern Ry. has done away with the key type of crosshead and is using the design in which the piston rod is held in place by a large castellated nut. As these nuts have worn out in service the mechanical department has been confronted with the problem of replacing them. The dies shown in the accompanying illustrations have been instrumental in solving the problem.

The illustration shows the dies with the various headers used for making both blank and castellated nuts. The dies in this case are made to fit a 6-in. Ajax forging machine. As is readily seen, they are sectional; each half-die consists of seven distinct pieces, and also each die may be said to be two-faced. They may be turned end for end in the machine, or the two outside faces may be made the two inside faces. This design is to accommodate a variety of sizes of nuts, which will be named later. The main body of the die as shown is made of cast iron. All the remaining pieces should be made of either soft steel or tool steel. If made of tool steel, the various laminations should be tempered; if soft steel is used, they should be case hardened. The four end plates shown bolted to the ends, serve to protect the cast-iron sections. As they wear away, they may easily be replaced or built up by the oxyacetylene process. As may be noticed, some parts are recessed out to carry plates. The object of this design is to facilitate replacement of these pieces in case of accident. The laminations are bolted to the body of the die by 1-in. studs.

Size of Nut, In.	Across Flats, In.	Style	Width of Nut, In.
4¼	6⅛	Hex—castle	3
3½	5½	Hex—castle	2½
4¼	6½	Hex—plain	3
3½	5½	Hex—plain	2½
3½	5⅜	Hex—plain	3

A separate plunger to fit the crosshead of the machine is not made for each size of nut. One main body only is made, and the various plunger heads, shown in the photograph, are fastened to this main body by setscrews.

The sides show the results of the two operations necessary to form a complete nut. The pieces are formed



DIES FOR PISTON-ROD NUTS

in the bottom recess of the dies. The bar stock is upset, and by the use of the proper plunger either a plain or a castellated nut is formed. The completed nut is shown below. It is formed in the top recess of the dies by punching out the center of the piece. One heat only is necessary.

The accompanying table shows the different nuts made in these dies.

Helpful Drafting-Room Kink

By William J. Gaffke

A good and inexpensive drafting-room kink for changing blueprints is shown in the illustration. The quill

HELPFUL DRAFTING-ROOM KINK

A is made from either sheet brass or copper about 0.01 in. thick and ¼ in. wide. It is inserted in the stopper as shown.

*Presented to the American Railway Tool Foremen's Association.

†Tool foreman, Chicago & Northwestern Ry., Chicago, Ill.

Machining and Gaging Methods From Pelton Shop

By Fred H. Colvin

SYNOPSIS—Methods which have been found satisfactory both as to quality and cost of apparatus in moderate quantities always contain suggestions for shops similarly situated. The methods here described include gaging the relative location of surfaces of a waterwheel governor base, a drilling base for waterwheel buckets, boring formed surfaces in a lathe and a drilling and filing jig for square holes.

One of the interesting products of the Pelton Waterwheel Company, San Francisco, Calif., is the Doble hydraulic governor, used in connection with the Pelton waterwheel, for controlling the flow of water to the wheel itself. Without going into the mechanism of this governor, it presents several interesting machining problems, some of which will be found in connection with the various surfaces of the governor base.

The top is first bored and faced, as shown in Fig. 1, all the other surfaces being gaged from this point. The base of this gaging is the located plate *A*, which is held in position by the four projecting lugs shown, while the two knurled handles afford an easy means of handling the center plate. The use of the gage *B* is shown in Fig. 2.

This figure shows the gage *B* in position in the plate *A*, the outer end giving the correct distance from the center of the governor base to the face of the side opening *C*.

The manner of gaging the opening on the opposite side, as well as the relative position of the rear bearing, is shown in Fig. 3. Here an arm *D* has been substituted for the gage *E* for gaging the height of the bearing with relation to the upper face of the base. The gage *E* locates the relative position of the end of the side bearing

Fig. 1

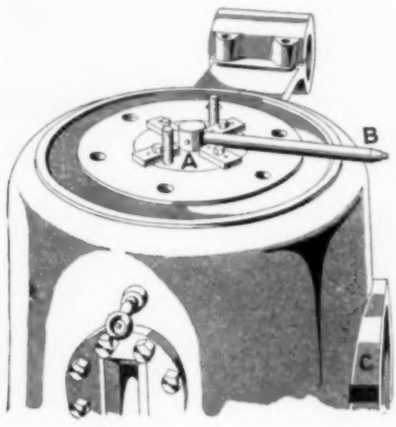


Fig. 2

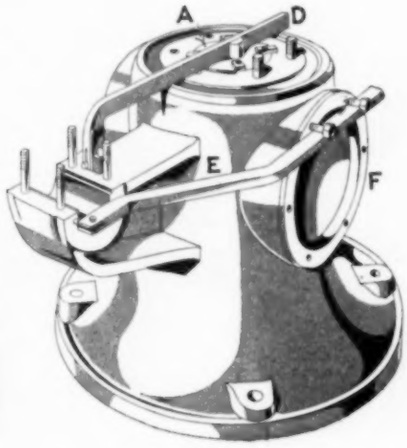


Fig. 3

FIGS. 1 TO 3. LOCATING GAGES FOR THE BASE OF WATERWHEEL GOVERNOR

Fig. 1—Center plate in place. Fig. 2—Locating the side outlet. Fig. 3—Gaging bearing surface and other side outlet

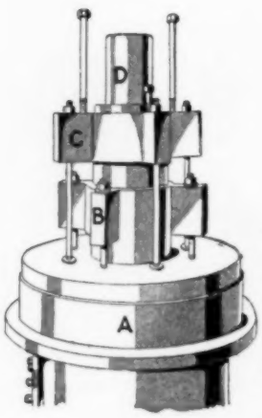


Fig. 4

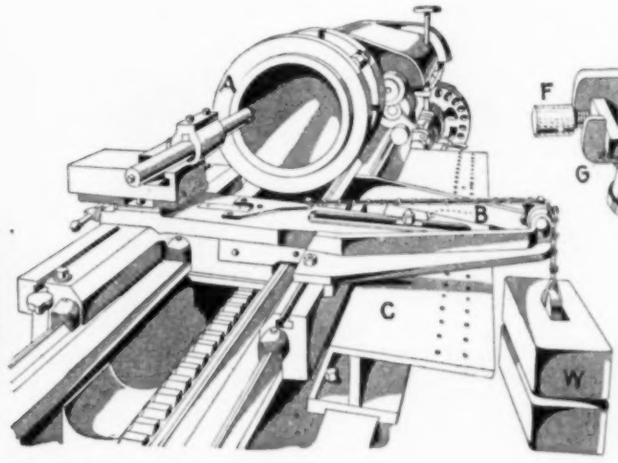


Fig. 5

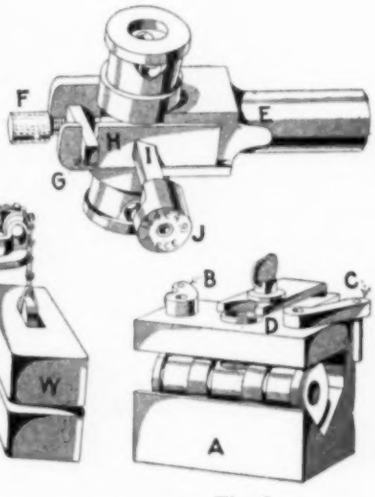


Fig. 6

FIGS. 4 TO 6—HAND AND MACHINE OPERATIONS ON GOVERNOR PARTS

Fig. 4—Post for wheel centers. Fig. 5—Boring the curved nozzle. Fig. 6—Drilling and filing jig for needle valve

and the face *F* of the opening on this side. Both of these gages have adjustable hardened points to allow for wear and to keep the setting accurate at all times.

For holding the waterwheel spiders, or centers, while they are drilled to receive the buckets, the stump, or post, shown in Fig. 4 is used. It consists of a base *A* which is strapped to the floor plate of a large radial drilling machine. This carries the pair of four-winged arms *B* and *C* on the central post *D*. The spider fits on these arms, which locate it in a central position while it is being drilled for the bucket.

The nozzle tips of the governor are bored to a special curve for controlling the flow of water to the best advantage, a central needle, curved somewhat similarly, being used inside the curved nozzle tip *A*, shown in Fig. 5. This is bored by means of a former, shown very slightly at *B*, this former being bolted to the plate *C* in the correct position to control the boring of the nozzle. The crossfeed screw is disconnected in the usual way, the cross-movement of the carriage being controlled by the weight *W*, through the chain belt shown. The carve on the governor spindle is turned in a similar manner.

The governor contains a floating valve, which has a square hole across the center, and which must be very accurate. Not being made in sufficient quantities to warrant broaching, these valves are drilled and filed, as shown in Fig. 6. The drilling jig is shown at *A*, carrying three bushings *B*, *C* and *D*. Only the central hole is filed square, the work being done in the filing fixture. The illustration shows very clearly how the piece is held by means of the knurled screw *F*, acting through the small strap *G*, which is easily handled in the notched plate *H*. The edges of the square hole *I* of the fixture are hardened, so that it makes the filing of this square hole a comparatively simple matter. The gage for testing the hole is shown at *J*.

Dressing a Wheel for the Grinding of Splines

By E. A. Thanton

One of the large automobile companies grinds its splined gear shafts all over after they are machined and hardened. These shafts are of the six-splined type, and in milling out the splines a small channel is cut down into the bottom of each side of the spline. This is done on account of the tendency of the edges of a grinding wheel to round over quickly. By milling in this way, a strip is left down the middle of the bottom, so that the wheel has a strip on the bottom and each side to grind, but no sharp corners.

After the shaft has been hardened, it is ground on a cylinder grinder and all the cylindrical surfaces finished. It is then placed in a Brown & Sharpe planer-type grinder, as shown in Fig. 1. The indexing is done with a regular dividing head, the same as in the milling operation. By the use of three specially mounted diamonds the wheel is dressed to the exact size and shape to grind the splines. These diamonds are carried in a fixture that is set on the grinder table in line with the shaft to be ground, as shown at *A*. By using this fixture the wheel is dressed to exact shape in a very short time with little trouble.

The method of mounting the diamonds is better shown in Figs. 2 and 3. In Fig. 2 the two diamonds used for dressing the beveled edges of the wheel are shown in position on the fixture. Each diamond is carried in a separate slide, as shown at *A* and *B*. The diamonds themselves are held in small plugs which are held in the slides by means of setscrews. The slides are permanently set in grooves cut at the correct dressing angle. They

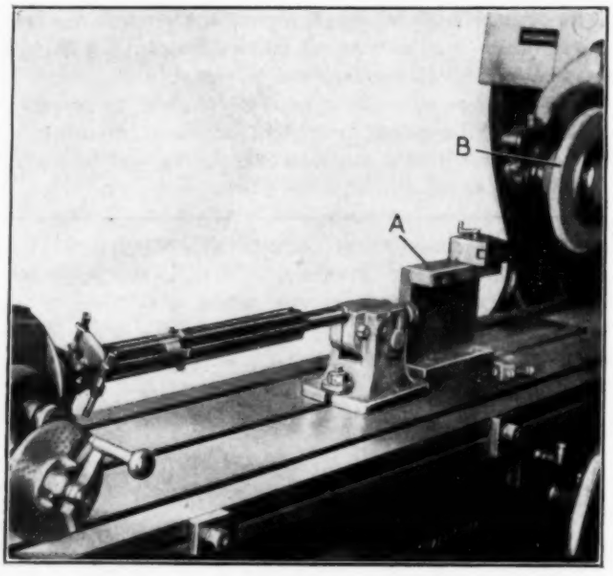


FIG. 1. DRESSING FIXTURE IN POSITION ON PLANER TYPE GRINDER

are each cut half away at the back so that they can cross each other. On the inner edges of the cut-away parts, teeth are cut like those of a rack, and into these teeth a small pinion meshes. This pinion is so set as to be turned by means of the handle *C*. By swinging this handle one way or the other, the slides carrying the diamonds are alternately fed out or in, and if in correct position the wheel will be dressed to correspond.

After the bevel edges, the radial periphery must be dressed. This is done without changing the position of the wheel or fixture. The double diamond holder is

FIG. 2. THE SIDE DRESSING DEVICE

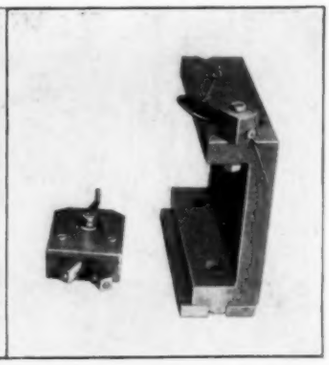


FIG. 3. THE RADIUS DRESSER

simply lifted upward off the engle plate and the single diamond holder put in its place, as shown in Fig. 3. As the diamond is held at *A*, the radius is dressed by simply swinging the handle *B* from side to side.

Effect of Varying Sulphur in Basic Openhearth Steel*

By J. S. Unger†

SYNOPSIS—Report of an investigation into the properties of a large number of steel specimens, including three different carbon contents and six or more sulphur contents for each carbon. Tests and observations were made in the laboratory, steel mill and shop. Summarizing, the author states, "I do not advocate paying no attention whatever to sulphur content of steel, but I firmly believe that a steel containing more than 0.100 per cent. is not necessarily bad and that it will show little, if any, difference in quality when compared with the same steel of much lower sulphur, other conditions being the same."

The purpose of this investigation was to prepare steels of different degrees of hardness, each containing varying amounts of sulphur, then work these steels into finished products and examine them carefully during the manufacture and after completion for difference in quality.

Three heats of steel of 68 tons each were made. These were low-sulphur basic openhearth steels of soft, medium and moderately hard varieties of approximately 50,000, 70,000 and 90,000 lb. per sq.in. tensile strength, the carbon contents being 0.09, 0.32 and 0.51 per cent. respectively. No selection of stock or furnace was made, the furnaces being taken at random. The heats were cast into twenty-four 18x20-in. ingots of 6,300 lb. each. Twelve ingots from each heat were used in the investigation, or a total of 100 tons. After a discard had been made to eliminate any highly segregated or streaked condition in the steel and the regular waste provided for, about 50 tons of steel was used in the tests carried out.

The sulphur content of the ingots was increased progressively by adding amounts of sulphur to different ingots from the same heat, raising the amounts in the higher-sulphur ingots of the series greatly beyond that ordinarily found in commercial steels, until a point was reached at which it was difficult, if not impossible, to roll the ingots by the usual heating and rolling operations commonly practiced at the mills.

The sulphur additions were made in the pure powdered form to the ingots during pouring. Pyrites was considered but discarded as a possible means of introducing variables. The additions were regulated to secure as nearly as possible a uniform increase of 0.030 per cent. sulphur from one ingot to the next higher. The aim was to obtain steels that, excepting sulphur, would be alike in manufacture and composition, thus keeping out any variables and furnishing an opportunity to study the effect of sulphur alone.

The ingots were rolled into such sizes as would be needed to fabricate the different steels, either by hot or cold working, into such finished articles as they were best adapted to by composition. Sheets, wire products, rivets, chains, tubes, channels, plates, rails, axles and drop forgings were made. In this paper I refer only to such steels as are of particular interest to the automobile industry.

Owing to the great variety of materials made, it was not always possible to use steel of the exact composition ordinarily employed for a certain purpose, as the steel was sometimes a little harder or softer than required. This feature does not, however, influence the comparative results.

The manganese of the three heats was 0.43, 0.62 and 0.67 per cent. respectively. Attention is called to this point, as large quantities of steel containing from 0.70 to 0.120 per cent. sulphur and 0.75 to 1 per cent. manganese are made regularly for consumers who must have a steel especially fitted for rapid drilling, turning or threading purposes. The comparatively high manganese in this screw or nut stock has an appreciable effect on the hot-working properties. This was not the case in the low-manganese steels studied in this investigation.

The ingots were heated to 1,250 deg. C. and then rolled in the regular way, no attempt being made to give the higher sulphurs any preference. All ingots were rolled, except the two highest-sulphur ingots of the 0.09 per cent. carbon heat, containing 0.250 and 0.254 per cent. sulphur. These ingots cracked badly in rolling and were removed from the roll tables and scrapped. In rerolling from the blooms, billets or slabs into finished material, no trouble was experienced nor any difficulties met.

TABLE 1. CHEMICAL ANALYSES AND PURPOSES FOR WHICH STEEL WAS USED

Basic Openhearth Heat No. 81,160:
Chemical Analysis—Carbon, 0.09; manganese, 0.43; phosphorus, 0.012; sulphur, 0.031.
Sulphur Content in Ingots—0.030, 0.031, 0.050, 0.060, 0.090, 0.116, 0.140, 0.160, 0.180, 0.250, 0.254.
Purposes for Which Used—Rivets, chains, sheets, wire, tubes and pipe.

Basic Openhearth Heat No. 71,163:
Chemical Analysis—Carbon, 0.32; manganese, 0.62; phosphorus, 0.014; sulphur, 0.032.
Sulphur Content in Ingots—0.032, 0.068, 0.108, 0.146, 0.190, 0.230.
Purposes for Which Used—Drop forgings, channels, plates and tubes.

Basic Openhearth Heat No. 76,185:
Chemical Analysis—carbon, 0.51; manganese, 0.67; phosphorus, 0.015; sulphur, 0.025.
Sulphur Content in Ingots—0.025, 0.055, 0.095, 0.135, 0.167, 0.230.
Purposes for Which Used—Axles, drop forgings, rails and wire rope.

Table 1 shows the chemical composition of each heat and the sulphur content of each ingot.

Hot-Working Properties of the Steel

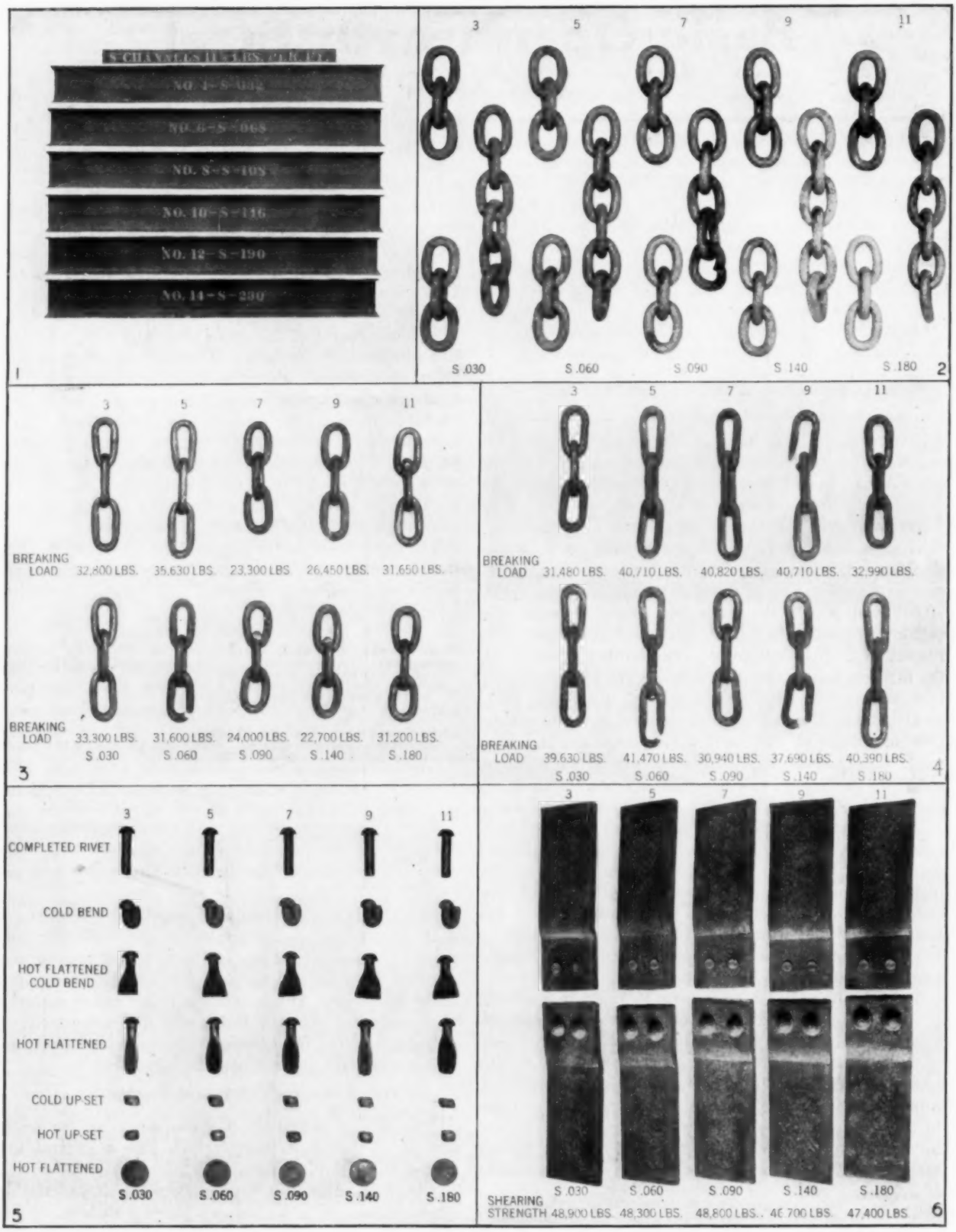
The rolling properties of these steels are shown in several of the illustrations, which give a general idea of the rolled finished material.

Channels enter into the construction of automobile-truck frames. Fig. 1 shows six pieces 6 ft. long, each of 8-in. channels, of 0.32 per cent. carbon steel, with the corresponding sulphur of each piece stenciled on the channel. No tearing or red shortness is noticeable on the thin flanges of the higher sulphurs.

The ability to weld the soft steel of 0.09 per cent. carbon is shown in Fig. 2 (¾-in. machine-made chain).

*Presented at the 1916 annual meeting of the Society of Automobile Engineers. Slightly condensed.

†Manager, Central Research Bureau, Carnegie Steel Co.



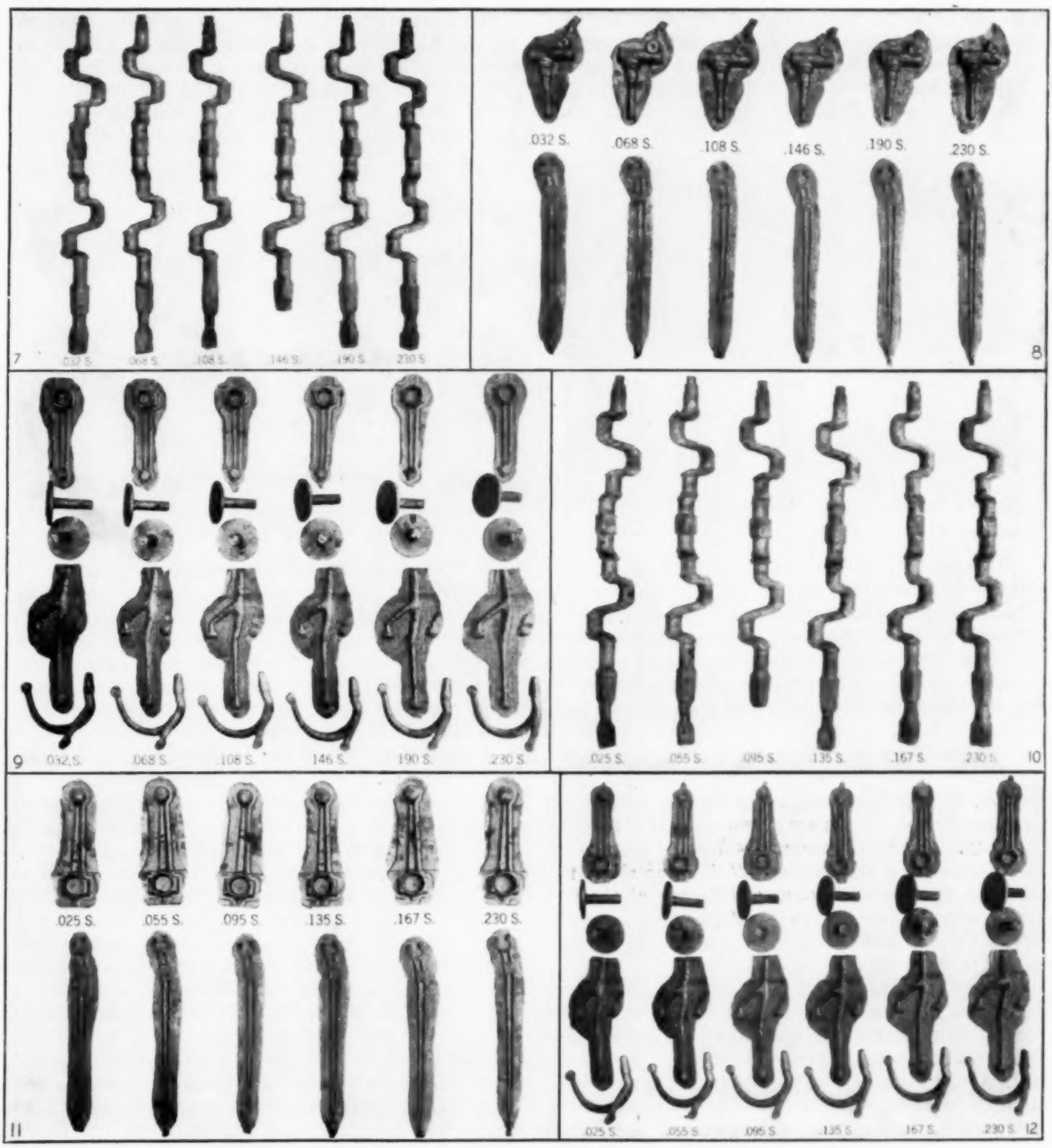
FIGS. 1 TO 6. TEST SPECIMENS OF CHANNELS, CHAIN AND RIVETS USED IN INVESTIGATION OF INFLUENCE OF SULPHUR IN STEEL

Fig. 1—Samples of 8-in. channels. Fig. 2—Welded ¾-in. machine-made chain. Fig. 3—Machine-made chain tested to destruction. Fig. 4—Hand-made chain tested to destruction. Fig. 5—Rivets subjected to hot and cold tests. Fig. 6—Riveted joints tested to destruction

Three pieces of each sulphur content were made. The short pieces of three links each were tested to destruction, with results shown in Fig. 3. Additional chain, hand-made, shown in Fig. 4, was tested. The stock for these chains was rolled $^1/_{64}$ in. light in gage, in order that this size could be used in making the rivets. This is not the usual practice, as machine-made chain stock is rolled $^1/_{32}$ in. over gage to provide for scaling and to fill out the welding dies of the hammer. This smaller diameter has given lower results than is ordinarily obtained on standard chain, but the results are truly comparative.

The greater average strength of the hand-made chain over the machine-made is not due to better workmanship, but to the fact that the lap in the hand-made chain is almost twice as long

No trouble was experienced in either the hand- or the machine-made chain until No. 9, or 0.140 per cent. sulphur, was reached, No. 11, of 0.180 per cent sulphur, acting similarly. It was found that both could be welded perfectly at the regular temperature and did give good results, but that lowering the welding temperature about 100 deg. C. prevented any cracking or crumbling of the steel in welding. The evidence seems to show that good and bad welds are more a question of heating and workmanship than of either high or low sulphur, as either kind of weld is found in any of the various chains tested.



FIGS. 7 TO 12. DROP FORGINGS MADE FROM STEELS CONTAINING DIFFERENT AMOUNTS OF SULPHUR

Fig. 7—Drop-forged crankshafts. Fig. 8—Automobile drop-forged parts. Fig. 9—Automobile drop-forged parts. Fig. 10—Drop-forged crankshafts. Figs. 11 and 12—Automobile drop-forged parts

The results of the tests to destruction are given in Table 2.

TABLE 2. BREAKING LOAD OF ¼-IN. CHAIN

Carbon Content, Per Cent.	Sulphur Content, Per Cent.	Breaking Load of Hand-Made Chain, Lb.	Breaking Load of Machine-Made Chain, Lb.
0.09	0.030	31,480	32,800
		39,630	33,300
0.09	0.060	40,710	35,630
		41,470	31,600
0.09	0.090	40,820	23,300
		30,940	24,000
0.09	0.140	40,710	26,450
		37,690	22,700
0.09	0.180	32,990	31,650
		40,390	31,200

A number of rivets, ¾ in. in diameter by 2 in. long under the head, of the 0.09 per cent. carbon steel were made and subjected to the various hot and cold tests shown in Fig. 5. To determine if these rivets were of the same strength under shearing stress, 10 bars, having two $\frac{13}{16}$-in. holes drilled 2 in. from one end, were riveted together by machine at an estimated temperature of 1,200 deg. C. These bars were then tested with the results shown in Fig. 6 and in Table 3. Practically no difference is observed in the tests.

A number of bars from both the 0.32 per cent. and the 0.51 per cent. carbon heats of various sulphur contents, 2x2 in. by 16 ft. long, were rolled and sent to two prominent automobile manufacturers with a request to drop forge them in accordance with their regular practice, into such shapes as would indicate if any difficulties would be encountered in the heating or forging.

The author was present when this work was done. Crankshafts, connecting-rods, steering knuckles and other parts were forged. These are shown in Figs. 7, 8, 9, 10, 11 and 12. The flash or excess metal forced out between the dies was not always sheared off, it being allowed to adhere to the forging to show any tearing at the thin outside edges. The appearance of the flash seems to furnish the strongest evidence of the ability of the high-sulphur steels to stand severe hot work.

The size, 2x2-in. bars, furnished the manufacturers was of too large a section to do the best work for a number of the smaller forgings. As a consequence, more actual work, or greater reduction, than in the regular practice was necessary to produce the forgings under the drop hammer. In the case of the crankshafts the regular stock used is 3½ in. in diameter, but in this case it was 2 in. square which did not give enough metal to fill the forging dies properly, leaving parts of the forgings in an unfinished condition. This is of no importance in these tests, as the object was to determine if the higher-sulphur steels would stand the severe bending necessary to forge these crankshafts.

When finished, these forgings were cleaned by dilute acid or the sand blast and then carefully inspected by the manufacturers and the author to detect any surface or other defects, but no differences could be observed in the high- and low-sulphur steels of either carbon.

TABLE 3. SHEARING STRENGTH OF RIVETED JOINTS

Carbon Content, Per Cent.	Sulphur Content, Per Cent.	Shearing Strength, Lb.
0.09	0.030	48,900
0.09	0.060	48,300
0.09	0.090	48,800
0.09	0.140	46,700
0.09	0.180	47,400

Fig. 13 is presented to give an idea of the cold-working quality of soft steel. A number of No. 26 gage sheets were rolled, then galvanized and afterward made up into spouting. In seaming and beading the spouting, no cracks developed on any specimen, while the coating adhered as closely to one sheet as to another. This work

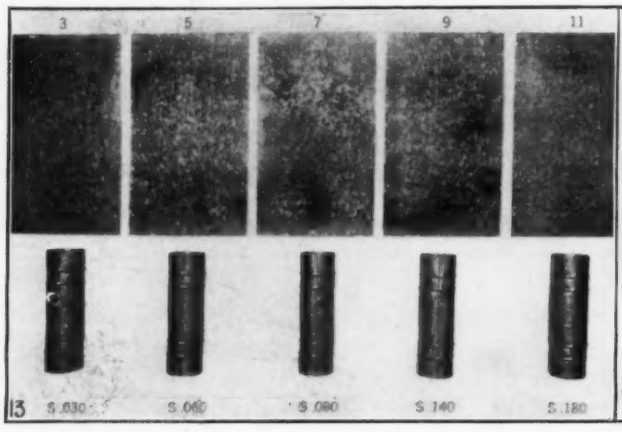


FIG. 13. SHEET STEEL GALVANIZED AND FORMED

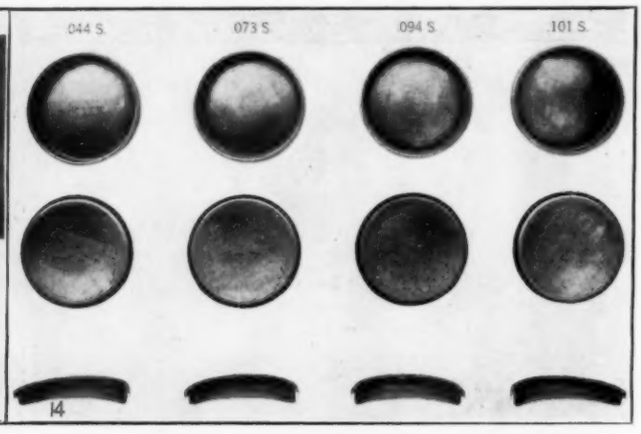


FIG. 14. MILK-CAN BASES WITH 0.09 CARBON

bears a close relation to the stamping or drawing of automobile mudguards, hood covers, bodies or other parts.

Another example is represented in Fig. 14 of a number of milk-can bases of 0.09 per cent. carbon steel of different sulphur contents. These bases were intended for 5-gal. cans, are 11 in. in diameter and of No. 16 gage sheet. The work done is very severe, being a reverse draw with two operations in the press. The illustrations show both sides of the bases, and in addition a cross-section of the base after cutting apart to show character of bend. No differences were noticed in stamping any of the specimens.

Tensile specimens were machined from the drop-forged steering knuckles of 0.32 per cent. carbon, shown in Fig. 8, after they had been subjected to the heat-treatment given in Table 4. Similar tests after treatment were made from the 1¼-in. diameter rounds used in drop forging the clutch pilots from the 0.32 and 0.51 per cent. carbon steels, shown in the third and fourth rows of Figs. 9 and 12. The results obtained are given in Table 5.

Short pieces of ¾-in. diameter rounds from the 0.09 per cent. carbon steel were packed in ordinary case-hardening compound in the same container, then heated to 900 deg. C. for 12 hr., afterward reheated to 860 deg. C. and quenched in cold water. The surface of the bars was roughly polished and the scleroscope hardness determined at several points on the surface. The depth of case and

hardness, which are the same for each bar regardless of the sulphur content, are found in Fig. 15.

Where any machining was done on the finished material, or in preparing test specimens before and after treatment, no material differences were found. The only noticeable thing was that the higher-sulphur steels of any carbon gave a smoother machined surface than the lower-sulphur under the same condition of feed, speed or depth of cut. In cutting threads on some 1¼-in. pipe a test was made by attaching an arm 22½ in. long to the die, the opposite end of the arm being attached to a dynamometer which registered the load in pounds. Table 6 gives the results on the 0.09 per cent. carbon steel. This shows the average power required while cutting 11½ threads per inch in ten samples of each sulphur content.

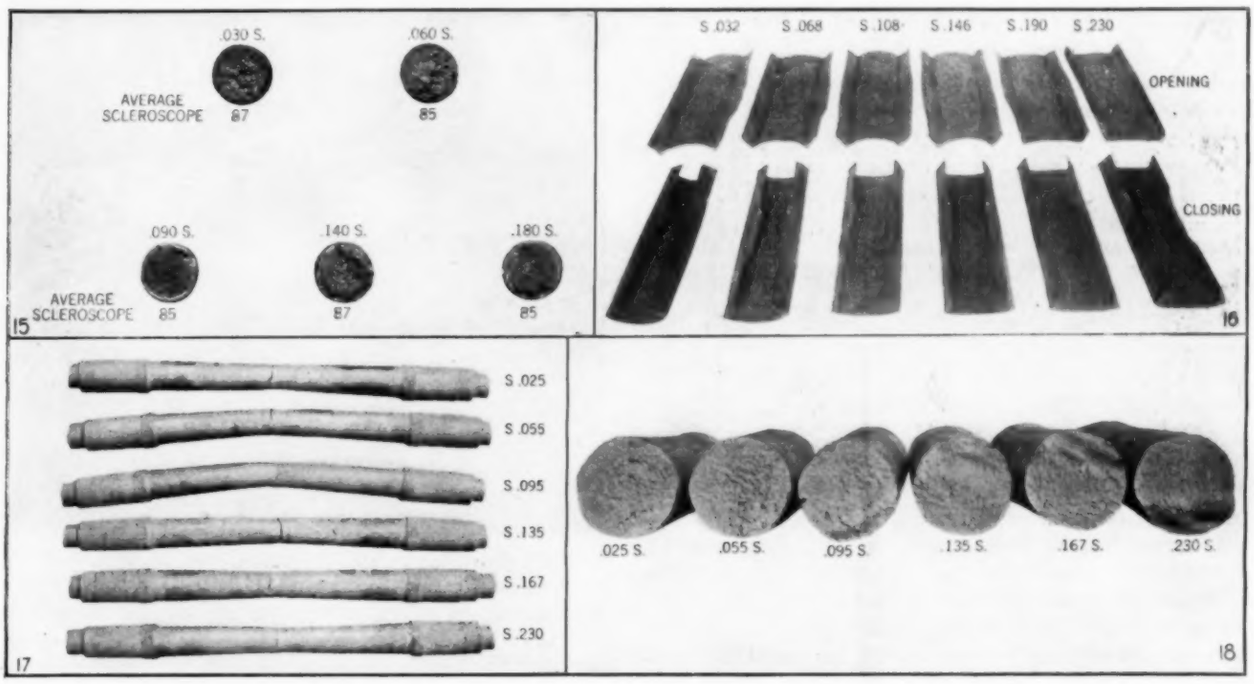
TABLE 4. TENSILE TESTS OF HEAT-TREATED STEERING KNUCKLES*

Carbon Content, Per Cent.	Sulphur Content, Per Cent.	Elastic Limit, Lb. per Sq.In.	Tensile Strength, Lb. per Sq.In.	Elongation in 2 In., Per Cent.	Reduction of Area, Per Cent.
0.32	0.032	62,250	83,250	30.0	60.0
0.32	0.068	49,375	78,375	31.5	62.8
0.32	0.108	52,750	77,750	30.0	58.0
0.32	0.146	58,875	77,875	27.0	61.3
0.32	0.190	51,875	76,875	28.0	53.8
0.32	0.230	57,250	76,250	29.0	53.8

*Annealed at 900 deg. C., reheated to 829 deg. C., quenched in water and drawn at 538 deg. C.

Tensile tests of ¾-in. diameter rounds of 0.09 per cent. carbon, of 8-in. channels of 0.32 per cent. carbon and of axles of 0.51 per cent. carbon, all in an untreated condition, are shown in Tables 7, 8 and 9. The results on the soft steel, Table 7, are the same. In the medium steel, Table 8, there is a slight falling off in the physical properties when the sulphur exceeds 0.100 per cent. The highest carbon, Table 9, giving the results on specimens taken at the edge and halfway to center of axles, shows that as the sulphur rises there is a decrease in the ultimate strength, but an increase in the toughness, as shown by the reduction of area.

The bending quality of the 0.09 per cent. carbon steel is shown in the tests of rivets, Fig. 5, the bending quality of the 0.32 per cent. carbon steel in the opening and closing tests of the 8-in. channels, Fig. 16. Bending tests were not made on full-size material made from the 0.51 per cent. carbon steel.



FIGS. 15 TO 18. SPECIMENS OF STEELS CONTAINING DIFFERENT AMOUNTS OF CARBON, USED IN CASE-HARDENING, BENDING AND DROP TESTS

Fig. 15—Showing hardness of case-hardened rounds. Fig. 16—Eight-inch channels after opening and closing tests. Fig. 17—Axles after drop test. Fig. 18—Ends of axles broken in drop test

TABLE 5. TENSILE TESTS OF HEAT-TREATED 1¼-IN. ROUNDS FORGED FROM 2x2-IN. BILLETS.

Carbon Content, Per Cent.	Sulphur Content, Per Cent.	Elastic Limit, Lb. per Sq.In.	Tensile Strength, Lb. per Sq.In.	Elongation in 2 In., Per Cent.	Reduction of Area, Per Cent.
0.32*	0.032	48,650	80,250	30.5	70.1
0.32*	0.068	48,550	75,550	32.8	68.8
0.32*	0.108	46,400	75,800	30.2	68.7
0.32*	0.146	46,700	73,350	31.5	67.3
0.32*	0.190	45,450	71,550	33.2	66.3
0.32*	0.230	45,850	70,100	31.5	65.0
0.51†	0.025	70,400	111,900	20.3	56.8
0.51†	0.055	76,300	120,800	19.7	51.3
0.51†	0.095	73,950	119,400	19.5	51.5
0.51†	0.135	76,800	120,600	18.3	49.2
0.51†	0.167	73,200	111,750	17.5	45.4
0.51†	0.230	66,350	106,550	20.5	44.7

*Heated to 830 deg. C., held for 20 min., quenched in water drawn at 600 deg. C., for 30 min.

†Heated to 816 deg. C., held for 20 min., quenched in water drawn at 565 deg. C., for 30 min.

TABLE 6. THREADING TESTS OF 1¼-IN. STEEL PIPE.

Carbon Content, Per Cent.	Sulphur Content, Per Cent.	Power Required for Cutting Lb.
0.09	0.031	73.5
0.09	0.050	70.6
0.09	0.090	68.5
0.09	0.116	62.3
0.09	0.160	61.2

TABLE 7. TENSILE TESTS OF UNTREATED ¾-IN. DIAMETER ROUNDS

Carbon Content, Per Cent.	Sulphur Content, Per Cent.	Elastic Limit, Lb. per Sq.In.	Tensile Strength, Lb. per Sq.In.	Elongation in 8 In., Per Cent.	Reduction of Area, Per Cent.
0.09	0.030	31,360	50,460	30.8	64.2
0.09	0.060	32,740	50,900	30.2	65.3
0.09	0.090	30,890	51,400	31.2	62.5
0.09	0.140	31,600	50,700	32.5	64.2
0.09	0.180	31,530	50,960	30.7	62.3

In addition to the tests already mentioned, deflection tests were made on the full-size channels and drop tests on the axles. The results of the deflection tests on the

channels are shown in Table 10, and the results of the drop tests on axles in Table 11. Fig. 17 shows the appearance of the broken axles, and Fig. 18 the fracture of each axle after breaking under drop.

The tables and illustrations in this paper present the actual evidence obtained in investigating steels of different degrees of hardness with varying contents of sulphur. Wherever possible, variables which might affect the results

TABLE 8. TENSILE TESTS OF 8-IN. STEEL CHANNELS

Carbon Content, Per Cent.	Sulphur Content, Per Cent.	Elastic Limit, Lb. per Sq.In.	Tensile Strength, Lb. per. Sq.In.	Elongation in 8 In., Per Cent.	Reduction of Area, Per Cent.
0.32	0.032	45,300	71,580	25.5	54.8
0.32	0.068	45,000	70,060	26.2	54.8
0.32	0.108	47,110	70,670	24.2	52.9
0.32	0.146	46,210	70,060	26.2	50.9
0.32	0.190	48,930	70,060	24.2	48.4
0.32	0.230	47,250	67,920	24.5	47.9

TABLE 9. TENSILE TESTS OF 0.51 CARBON UNTREATED AXLES*

	Specimen Cut from Edge of Axle				Specimen Cut Halfway from Center of Axle			
Sulphur Content, Per Cent.	Elastic Limit, Lb. per Sq.In.	Ultimate Strength, Lb. per Sq.In.	Elongation in 2 In., Per Cent.	Reduction of Area, Per Cent.	Elastic Limit, Lb. per Sq.In.	Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., Per Cent.	Reduction of Area, Per Cent.
0.25	44,320	92,160	22.0	34.5	45,390	95,270	20.5	29.4
0.055	41,250	91,670	20.5	35.7	41,470	92,460	20.5	34.0
0.095	43,220	85,650	22.0	35.8	43,300	84,360	20.5	39.9
0.135	35,770	81,330	23.0	35.9	35,260	80,370	23.5	37.8
0.167	35,400	80,340	22.0	34.3	39,630	81,760	20.5	33.1
0.230	36,930	80,060	22.0	34.6	35,070	77,770	24.0	35.2

*Axles 4¼-in. in diameter at center. Journal 4¼x8 in.

TABLE 10. DEFLECTION TESTS ON 8-IN. STEEL CHANNELS*

Carbon Content, Per Cent.	Sulphur Content, Per Cent.	Load to Deflection, Lb.	Permanent Deflection, In.
0.32	0.032	22,400	0.04
0.32	0.068	21,900	0.04
0.32	0.108	22,500	0.04
0.32	0.146	22,300	0.04
0.32	0.190	23,200	0.04
0.32	0.230	23,100	0.04

*Deflection tests made on full-sized 8-in. channels, 11.25 lb. per sq.ft., 48 i between centers. Load applied at center.

have been avoided. In practically every case, finished articles in common everyday use were made. The work was carried out by the ordinary methods practiced, and in such sizes as are manufactured in the mills or shops.

The results presented speak for themselves and need very little comment. I do not advocate paying no attention whatever to sulphur content of steel, but I believe firmly

TABLE 11. DROP TESTS OF 0.51 CARBON UNTREATED AXLES*

Sulphur Content, Per Cent.	Number Blows to Break Axle	Deflection in in. after each blow. Axles turned over after every second blow.						
		First Blow	Second Blow	Third Blow	Fourth Blow	Fifth Blow	Sixth Blow	Seventh Blow
0.025	33	4⅛	5⅛	3⅛	5⅛	3⅛	5⅛	3
0.055	20	4⅛	5⅛	3⅛	5⅛	3⅛	5⅛	3⅛
0.095	30	4⅛	5⅛	3⅛	5⅛	3⅛	5⅛	3⅛
0.135	30	4⅛	6	3⅛	6	3⅛	5⅛	3⅛
0.167	21	4⅛	5⅛	3⅛	5⅛	3⅛	5⅛	3⅛
0.230	14	4⅛	5⅛	4	5⅛	4	5⅛	5⅛

*Axles rough turned. Size 4¼-in. in diameter at center. Journal 4¼x8-in. Weight of tup, 2,200 lb. Height of drop, 16 ft.

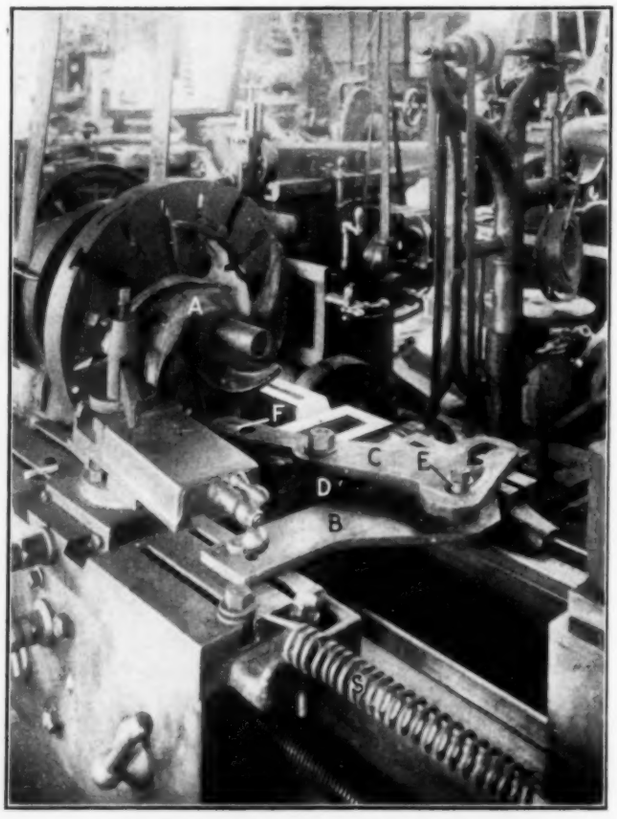
that a steel containing more than 0.100 per cent. is not necessarily bad, and that it will show little, if any, difference in quality when compared with the same steel of much lower sulphur, other conditions being the same.

Side-Forming Device

An interesting and unusual forming device is used to get a special shape on the blade of a pump impeller. This special shape comes on the side of the impeller, eliminating the usual forming arrangement at the back.

The plate *B* is bolted across the wings of the carriage and carries the stud and roller *E*. The plate *C*, having the curved form of a slot in the end, is pivoted at *D*, the slot in the other end working on the pin *F*. The crosspiece *D* is clamped rigidly to the bed and forms the fixed point from which the carriage is moved. The spring *S* takes up all slack between the roller and the formed slot.

As the tool is fed into the work by the cross-slide, the pin *F* forces the plate *C* to move around the pivot *D*.



TURNING A FORMED PUMP IMPELLER

This forces the curved slot in the end of plate *C* against the roller *E*, and as the pivot *D* is stationary, the carriage carrying the tool is moved to conform with the shape of the slot. This type of forming device is out of the ordinary and is one which should have numerous applications. It is from the shop of Meiss & Gottfried, San Francisco, Calif.

Savings Bank Life Insurance

At the Norwood Engineering Co., Northampton, Mass., a mutual benefit association has been formed, providing sick benefit of $5 a week.

The Norwood Engineering Co. has agreed to furnish $100 life insurance for each employee who becomes a member of the association. This insurance is taken out through the Massachusetts Savings Bank Life Insurance, under a group insurance contract by which all members of the association are protected. On these group insurance contracts this year the savings insurance banks are paying a dividend of 50 per cent. of the year's premium.

This is a businesslike form of coöperation between employer and employee. The employee provides for his own sickness insurance and the employer provides for his life-insurance protection.

Already 170 of the employees of the Norwood Engineering Co. have become members of this association.

Personal Reminiscences of James Mapes Dodge--II*

By Charles Piez†

SYNOPSIS—In this second part the author reveals the lasting influence of Mr. Dodge in softening and humanizing the Taylor system of management at the time it was installed in the Philadelphia plant of the Link-Belt Co. A number of important inventions in the conveyor and power-transmission field were also brought out after 1900. But important as all these achievements are, his friends will remember Mr. Dodge longest for his magnetic personality, quick sympathy and never-hesitating helpfulness.

In the midst of his activities in development and invention Mr. Dodge never failed to pay attention to the human side of the industrial problem. His sunny optimism, his personal interest in every employee and the ease with which he could be approached on personal or business grounds made him a prime favorite among the men. His office door was always open to any employee, no matter how lowly, and tales of unfairness whether of rates or treatment received earnest attention and resulted in prompt and corrective action. His invariable injunction to his aids concerning the treatment of workmen was, "In case of doubt decide against the company and in favor of the man." Men brought to him stories of their personal troubles, and he always lent a helping hand to tide them over a difficulty. Under such even-handed and considerate treatment no threat of strike ever appeared on the horizon of our Philadelphia plant, and even the radical changes involved in the installation of the Taylor system were met with tolerance and coöperation. Mr. Dodge described his relationship with his men in unusually happy fashion when, in answer to the question, "What is your relation with your men?" put to him by a member of the Federal Commission on Industrial Relations, he said, "Well, I don't know exactly, but I think most of them are more inclined to call me Jim than they are Mr. Dodge." "Training men into our methods and habits costs money, so don't fire a man unless you have a good reason, and not then until after you have talked it over with the superintendent," was his constant admonition to those in charge of employees.

He was equally sane on the treatment of customers. "We are prepared at any time to send out a salesman at an expense of a hundred dollars or more to secure a customer, and our accounting department will break with him over a difference of 40 cents." "If we allowed every demand that was made by our customers without question, we would save time, create good will and be money ahead in the end," were some of his business maxims.

His directness of method was well illustrated in his treatment of our Philadelphia purchasing department. This department, while under able management, had so buried itself under a mass of records that an investigation was ordered. The examination revealed that the large purchases were all made on yearly contracts and that, eliminating these, the cost of purchasing the remainder ran about 15 per cent. Soon after, during one of our morning conferences, he said, addressing our buyer, "Ed, do you believe in the honesty of the average man?" "Of course," replied Ed. "Well, suppose we distribute our orders each morning without asking for price, would we have to pay 15 per cent. more than we pay now?" "No," said Ed, "I believe most of the sellers, in their desire to retain our business, would sell much closer to the market than that." "Then we can save money by abandoning our purchasing department," said Mr. Dodge, and with a few additional words of enlightenment Ed decided to return to simpler methods.

Mr. Dodge's Interest in Taylor-White Steel

It was but natural that Mr. Dodge, with his strong leaning toward the new and untried, should evince intense interest in so epochal an event in the mechanical world as the discovery of Taylor-White tool steel. From the very first he was an ardent champion of its possibilities and was eager to give it a trial in our Nicetown plant. We secured shop rights for its use at both Chicago and Philadelphia and immediately proceeded to test its possibilities when applied to the machining of cast iron. Mr. Taylor's own experiments had up to that time been confined largely to the turning of steel, and it was at our Nicetown plant that the feed and speed possibilities of Taylor-White tool steel applied to cast iron were first determined. Under the infection of Mr. Dodge's enthusiasm our entire organization suffered for a time from a mild form of speed mania, and officials and machinists vied with each other to establish new records in the amount of metal removed per hour. Our line-shaft speeds were doubled, our power plant had to be materially enlarged, and as a final step to secure the desired flexibility in both power and speed, the line shafts were abandoned and individual motor drives introduced in their place.

For a year or more the orderly procedure of our machine shop was seriously disarranged by the attempt to drive the machine tools to the limit of the tool-steel capacity. The output was increased, but breakdowns were so frequent that the increase in expenses more than outweighed the advantage of added output. It was then that Mr. Dodge realized that the burden of changing equipment and methods to meet the possibilities of the new tool steel was too severe to impose on an organization already fully absorbed in looking after the needs of the company's regular business. He consulted Mr. Taylor about our predicament, and Mr. Taylor suggested that we employ Carl Barth, one of his aids, to assume charge of the changes brought about by the use of the Taylor-White tool steel. Mr. Barth had had considerable experience in the machining of steel, but realizing that we were suffering from the lack of accurate data

*The first installment of this article was published beginning on page 101.

†President, Link-Belt Co.

on the speeds and feeds possible on cast iron, he at once inaugurated an exhaustive series of tests. While these were being carried on, saner cutting speeds were advocated, the toolroom was thoroughly reorganized and machine tools rearranged and rebuilt. Under Mr. Barth's intelligent direction both equipment and men were well prepared before the first actual step of producing work at high speed was undertaken. And his work was thoroughly done, for once begun, the work of changing over to the new feeds and speeds proceeded rapidly.

While this work was going on, Mr. Dodge became much enamored of the Taylor system, which had but shortly before been outlined in Mr. Taylor's famous paper presented before the American Society of Mechanical Engineers. At Mr. Dodge's request Mr. Taylor agreed to assume general direction of the introduction of the system, and Mr. Barth was retained to undertake the actual work.

While the work Mr. Barth began with proceeded rapidly and very satisfactorily, and while the actual reorganization of toolroom and machine-shop equipment, and let it work until we found that, after all, it accomplished nothing of itself, that it merely indicated the easiest lines along which work could be accomplished.

Mr. Dodge's contribution to Mr. Taylor's work, while not reflected in any of the forms or details of the system, was nevertheless an important one, for his influence lay wholly on the side of recognizing the human side of the management problem. Mr. Taylor's mind was essentially analytical and mathematical. He was inclined to consider workmen as wholly impersonal beings and to disregard the effect of prejudice and sentiment on output. His tendency originally was to concentrate all direction and initiative in the planning room and to insist that the men follow the strict letter of their instructions. It was due largely if not wholly to Mr. Dodge's influence with Mr. Taylor that the Taylor system lost its seeming asperities and harshness. And this was brought about not by any distinct modifications in the system itself, but rather by cultivating in the men who applied the system an appreciation of the human factor in scientific management. For after all there is nothing in-

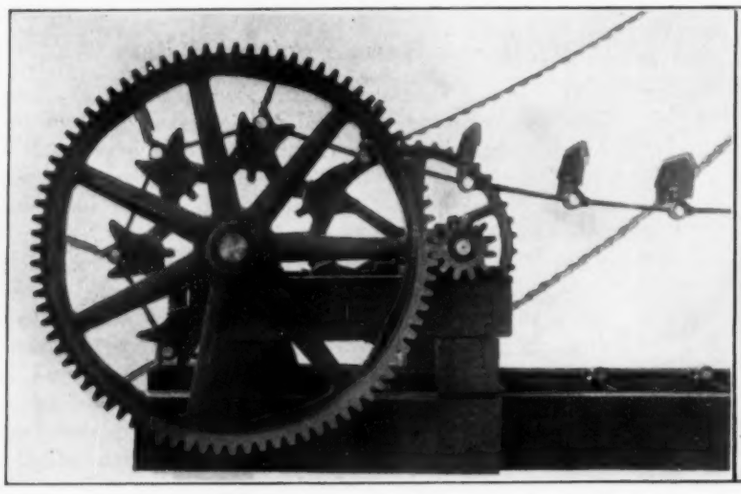


FIG. 1. EQUALIZING GEAR FOR LONG PITCH CONVEYOR CHAIN EXTENSIVELY USED

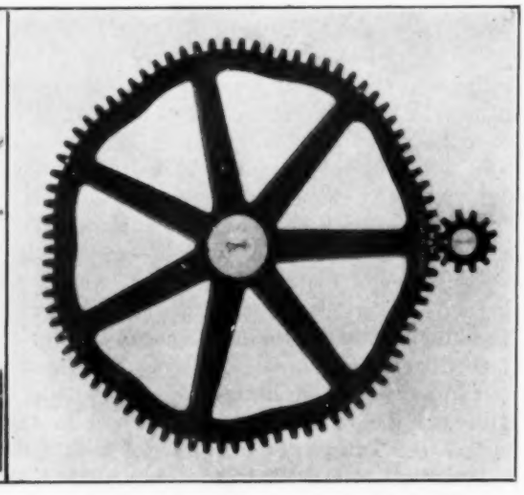


FIG. 2. LOBULAR GEAR AND ELLIPTICAL PINION OF EQUALIZING MECHANISM

the installation of functional foremanship and the establishment of rates based on unit time study and supported by instruction cards were accomplished in remarkably good time and with less embarrassment than was thought possible, the rest of the work gave considerable trouble before a perfect scheme of routing and of coördination of the various functions and departments was established. Much of our trouble arose from the facts that the attempt was made to fit the business to the system and that insufficient advantage was taken of methods which years of experience in our peculiar line had developed. Rigidity in any system is a serious if not a fatal disadvantage, and this truth was as much impressed on Mr. Taylor as on the rest of us before the work was completed, for it was only after we made certain departures from the rigid formula of the system that difficulties began to disappear and progress became rapid. It must be remembered that ours was the first plant of any size that was thoroughly systematized on Taylor lines, and difficulties were therefore to be expected. We had all labored under the impression that the system was a complete entity that required but a thorough understanding to work miracles. We were all inclined to stand aside

herent in the Taylor system that marks it as an especially attractive instrument in the unwholesome process of grinding blood money out of the workers. Like every other method or system of industrial organization, it can be used to the disadvantage of the men, but that abuse lies in the application and not in the system itself. As a matter of fact the greater preparation which a management must undergo to install the system, the greater accuracy with which the various steps must be taken and the greater dependability of its records, all make for greater honesty and a broader and more liberal attitude in its application. Certain it is that in our own plants the system has proved highly satisfactory. That it has worked no hardship on our workmen is attested by the fact that although a very active campaign has been waged in Philadelphia to secure machinists and tool makers for several new munitions plants, and although high wages and exceptionally liberal bonuses have been offered, not a single machinist or tool maker has been lured away from our Philadelphia plant.

But interested as Mr. Dodge was in the installation of the Taylor system, his active mind could not find entertainment in the slow and tedious process of teaching an

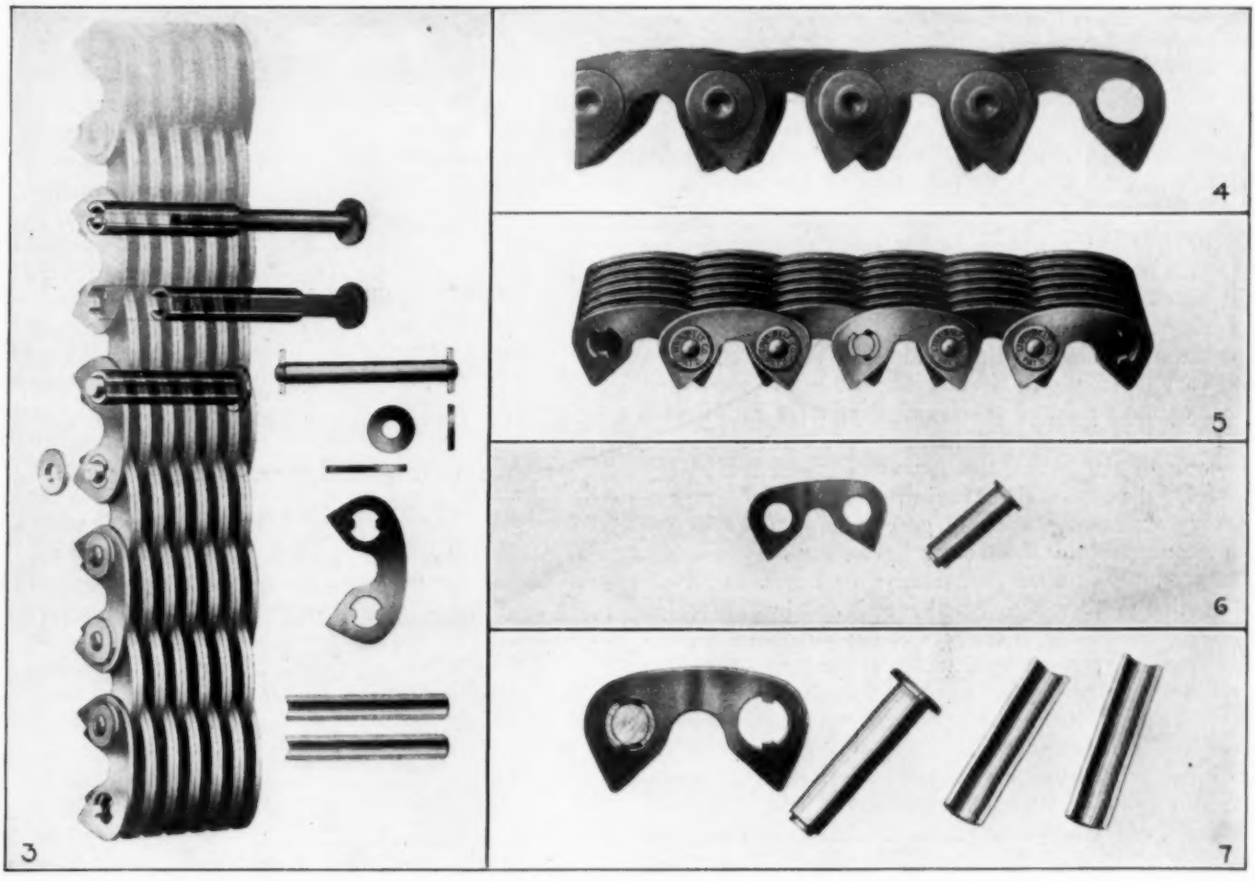
old organization new habits; and so he reverted constantly to the realm of invention and improvement. During the development of our conveyor business we had shown an increasing tendency toward the use of chains of a pitch of 18 in. and more. These chains were adopted both because they were cheaper and because, in such cases as bucket carriers, they lent themselves better to the purposes of the conveyor structure. One serious drawback to the use of these chains arose from the fact that wheels of relatively small diameter, which had to be used to economize head room, imparted a very irregular motion, or surge, to the conveyor.

A popular size of wheel for an 18-in. pitch chain is 41 in. in diameter and has 7 teeth. By looking at Fig. 1, it will be seen that as the link enters engagement with the sprocket it is carried forward along that part of the arc that has a large horizontal and a very small vertical component. As the wheel revolves, it carries the link up the ascending arc, where the horizontal component lessens and the vertical component increases. If the link in engagement is considered as a connecting-rod between the revolving sprocket and the remainder of the conveyor chain, the analogy between its operation and that of an engine connecting-rod becomes apparent. The only difference is that the chain link is carried through an arc of about 51½ deg. when the next link engages, while the connecting-rod head describes the full arc of 360 deg. But in spite of the small arc passed through, there is a decided acceleration and retardation during the engagement of each chain link. In a conveyor employing 18-in. pitch chain and running at 120 ft. per minute these pulsations occur 80 times per minute; and when the conveyor is long, they become greatly magnified by the elasticity of the chain. The resulting surging of the conveyor is decidedly destructive to the integrity of the conveyor mechanism, besides being unsightly in appearance.

Mr. Dodge solved this problem in characteristically simple fashion by imparting pulsations to the rotating conveyor shaft which completely counteracted the pulsations in the conveyor.

This was accomplished by using between the head and the countershaft a set of gears, of which the pinion was elliptical and the gear lobular, the number of gear lobes corresponding to the number of teeth in the conveyor sprocket, see Fig. 2. The gears imparted the desired corrective action to the shaft, and the conveyor chain at once assumed habits of regularity. Equalizing gears, as we call these compensating gears, have been almost universally adopted for driving long-pitch chain conveyors.

In spite of the great varieties of chain which we manufactured and in spite of the very considerable contributions which Mr. Dodge's inventive genius had made to this part of the work, he remained under the impression that the universal chain had not yet been developed. He had a theory that if you kept yourself in a receptive mental condition, some thought wave carrying the solution of



FIGS. 3 TO 7. STEPS IN THE DEVELOPMENT OF MR. DODGE'S BUSHED SILENT CHAIN

Fig. 3—Ghost view of Dodge bushed silent chain. Figs. 4 and 6—English type using plain link and pin. Figs. 5 and 7—Elements of Dodge type of bushed silent chain

the problem confronting you would strike a sympathetic chord in your mind, and he had a habit of sensitizing his mind to possible impressions.

Some time in 1899 he conceived the idea of the silent chain—that peculiar form of link which greatly reduced the noise of engagement with the sprocket. When he got to the patent office, however, he found that Hans Renold, of Manchester, England, had anticipated him. So highly did Mr. Dodge value the opportunities that this type of chain offered that I was immediately dispatched to England to secure the American rights from Mr. Renold. This was done in 1900, and in the following year we placed upon this market the first American-made Renold silent chain. Our business in this new line developed rapidly—more rapidly at first than our experience warranted—but we learned rapidly, and with Mr. Renold's experience to draw on, avoided many of the pitfalls that usually beset new ventures. But we were unwilling to proceed as cautiously in the application of the chain as Mr. Renold was proceeding, and with the daring that is characteristic of American business we soon launched into the field of large power transmissions.

The inherent weakness of the original English type of chain rapidly developed in these larger installations, for pins began to cut and the holes in the links to enlarge. We tried high-carbon steel links and then turned to casehardening both links and pins; but these proved but partial remedies. Mr. Renold, who had in the meantime encountered the same difficulty, tried to increase durability by forcing casehardened steel thimbles into the eyes of the links. But it was not until Mr. Dodge invented the bushed silent chain that this new medium of power transmission achieved general and successful application. Instead of adhering to circular bushings, Mr. Dodge employed through bushings, or liners, as an examination of Figs. 3 to 7 will reveal, and by this means succeeded in giving to each set of opposing links a bearing extending across the full width of the chain—a unique and heretofore unheard-of result in the cylindrical bearing of a multi-leaf chain. With both pins and bushings hardened and with avenues of lubrication opened up by the peculiar construction of the joint, the difficulties standing in the way of the rapid expansion of the silent-chain business were cleared away, and Mr. Dodge had achieved another conquest of the impossible.

As an evidence of the versatility of his genius it is interesting to recall that in 1873 he secured a patent on a chain-oiling street-car axle bearing, perhaps the very first self-oiling bearing employing a chain to lift and distribute the lubricant. The folding theater seat, in which the back assumes a vertical position when the seat is folded up, and the wire hat-rack so universally used under the seats of theater chairs are both contributions of Mr. Dodge to the convenience of the public.

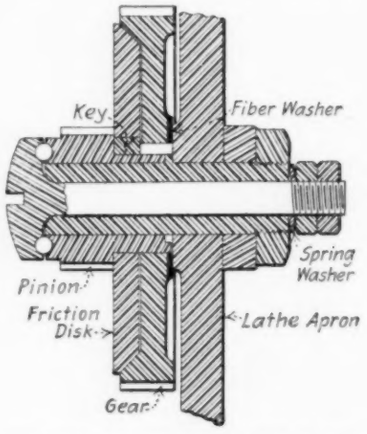
But his friends will longest remember his singularly magnetic personality, his quick sympathy, his never hesitating helpfulness; and they will remember too his buoyant good-fellowship, his unfailing wit and his unusual ability as a raconteur. His conception of duty to his family, to his employees and associates and to the public was a broad and generous one, and he strived conscientiously to discharge it. His life was therefore a full one, and measured by accomplishment, by public and personal duties well performed, a highly successful one.

Friction Crossfeed for Lathe

By A. F. Svensk

The illustration shows a friction adjustment that may be interesting to the users of the Reed-Prentice all-gear feed lathe.

Having quite a lot of trouble with gears breaking, owing to positive feed, we made this device. After fitting



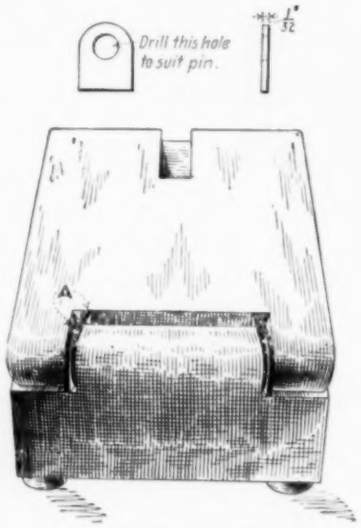
FRICTION CROSS-FEED FOR LATHE

the crossfeed with it the problem was solved, and it proves amply strong to operate for any chip that the lathe makes.

Wearing Plates for Jigs

By B. Maxim

The illustration shows a jig body equipped with hinge wear plates *A*. These plates have the same shape as the hinge, with a hole to suit the diameter of the pin.



WEARING PLATES FOR JIG

The ends of two of the plates fit in a slot in the lid, and the other plates fit in the slots in the body. These slots prevent the plates from turning.

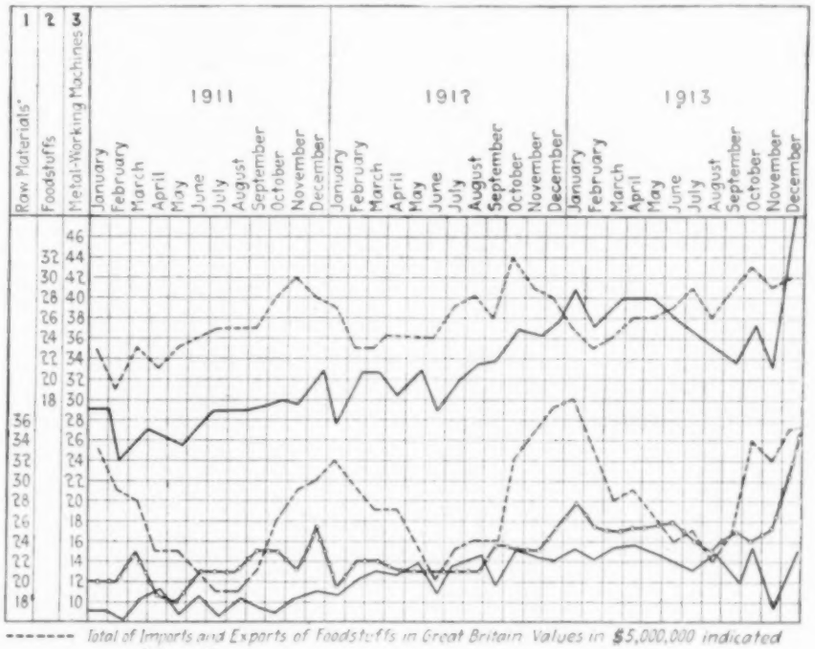
The plates are used only on jigs where the work is very accurate and when life of the jig is considered. They are made of tool steel, hardened and ground.

Relation Between Foodstuffs and Machine Tools

By Ludwig W. Schmidt

SYNOPSIS—An attempt to discover the relation, if one exists, between the demand for foodstuffs and for machine tools. Statistics for 1911, 1912 and 1913 are analyzed. Comparison seems to show that the demand for machine tools rises and falls with the demand for foodstuffs, with a lag in point of time of some two or three months.

In Vol. 43, page 197, of the *American Machinist* was reported an investigation into the forces which influence the demand for metal-working machines. Proof was brought to show that while the ultimate reason for an increase in the demand for metal-working machinery is an increased activity in the manufacture of other kinds of machinery, this increase is invariably preceded by an increase in the demand for foodstuffs. The investigation was based on figures from the years 1904 to 1913 and included especially the foreign field. An investigation of this sort, however, necessarily must remain only an academic enjoyment if there is no possibility of employing in practical life the experience gained. This condition would be the case if it were impossible to predict, by a close watching of certain happenings in other economic fields, a coming increase or decrease in the demand for machinery. It is further clear that such a prediction can only be of use to the manufacturer of metal-working machines when it comes in time for him to prepare for what is to follow. Therefore figures for any one year are of little value because they come too late.


1
2
3
Raw Materials*
Foodstuffs
Metal-Working Machines
1911
1912
1913
January
February
March
April
May
June
July
August
September
October
November
December
Total of Imports and Exports of Foodstuffs in Great Britain. Values in $5,000,000 indicated in Column 2
Total of Exports of Metal-Working Machines of the United States, Germany and Great Britain and Imports of Germany and Great Britain. Values in $1,000,000 indicated in Column 3
Total of Imports and Exports of raw Materials for Manufacture of Great Britain. Values in $5,000,000 indicated in Column 1
Exports of Germany of Metal-Working Machines. Values in $100,000 indicated in Column 3
Exports of the United States of Metal-Working Machines. Values in $100,000 indicated in Column 3

COMPARATIVE FLUCTUATIONS IN TRADE IN FOODSTUFFS, RAW MATERIALS AND METAL-WORKING MACHINES

To complete this line of economic research, the experiment has therefore now been narrowed down to a small field. An investigation has been made into the comparative relation of the demand for foodstuffs and for metal-working machines for the years 1911, 1912 and 1913. This investigation was carried on month by month, and the reader will see that valuable information has been gained which may lead ultimately to the establishment of an index figure for a coming metal-working machinery demand. Such an index figure at first may only indicate a coming decrease or increase without stating how large the movement promises to be. But even if so much may be gained, mistakes in manufacturing policy may be prevented.

The years 1911, 1912 and 1913 were selected because they were fairly normal years, showing in general a steady increase of business with the usual fluctuation which will always take place during any one year. It may be added that a short investigation covering the six months before the outbreak of the European War and the last twelve months since the coming of that event have proved to some extent the correctness of the rule gained by the analysis of former years. I do not like to lay too much stress on this fact, however, as it may be only a coincidence. Certainly the record of the disturbed months of the war should not be used for proving any elementary economic fact. To allow the reader to check the figures and results by his own experiences, I will explain briefly how the statistics have been obtained and grouped. It is impossible to gain any exact figures relating to the turnover inside the boundaries of any of the large metal-working machinery producing countries like the United States, Germany or England. The only fairly reliable figures are those relating to foreign trade, and they have been used again in this study, as in the case in the former experiment described in the article previously mentioned.

Table 1 is a detailed statement of the imports and exports of metal-working machines during each month from January, 1911, to December, 1913, for England and Germany. In the case of the United States only the export statistics are given, for the reason that the bulk

of the imports into the United States are contained in the English and German export figures. The sixth column of the table shows the total turnover of imports and exports of England and Germany and the exports of the United States, giving approximately two-thirds of the total foreign turnover of metal-working machines of the world. These totals should be comprehensive enough to allow for a deduction with regard to the movement of the business done in metal-working machines in the world. A manufacturer might possibly be able to deduce from his own records how far those movements are reflected in his own sales. He would have to take into consideration the fact that the American market is less dependent as a rule upon the general trade fluctuation of the world than other markets, especially the English.

Table 1 is interesting not only because of its relation to the present investigation, but for the purpose of comparison. Especially is the comparison with Germany instructive, showing as it does that in many cases the German exports of metal-working machines have gone rapidly ahead and American exports have declined. This fact to some extent seems to prove that the American

TABLE 1. FOREIGN SALES OF METAL-WORKING MACHINES OF THE UNITED STATES, ENGLAND AND GERMANY DURING 1911, 1912 AND 1913

	Imports		Exports			Total Turnover in Foreign Trade
	Germany	Great Britain	Germany	Great Britain	United States	
1911						
January	142,000	60,285	1,161,000	603,685	829,455	2,796,425
February	150,500	44,730	1,137,500	234,290	748,084	2,351,104
March	165,000	155,560	1,477,750	348,580	935,865	2,631,675
April	125,000	133,295	1,013,000	261,120	1,007,920	2,540,335
May	236,750	109,880	931,750	305,170	879,985	2,463,535
June	134,750	80,740	1,201,000	329,125	936,653	2,682,268
July	190,750	62,665	1,218,500	257,140	789,846	2,728,268
August	219,500	76,515	1,271,750	292,515	912,759	2,773,039
September	191,500	38,285	1,475,250	266,620	838,282	2,809,937
October	210,500	68,865	1,413,250	421,675	804,468	2,918,758
November	151,250	125,140	1,202,500	442,450	967,608	2,898,948
December	105,750	105,155	1,641,500	339,855	1,094,210	3,262,563
1912						
January	205,400	106,140	1,012,000	363,645	989,353	2,676,538
February	208,000	136,255	1,372,000	403,410	1,134,925	3,254,590
March	219,000	120,495	1,334,250	357,420	1,207,787	3,238,952
April	188,000	146,225	1,205,250	335,980	1,164,910	3,040,365
May	190,250	114,365	1,276,750	325,165	1,272,536	3,279,066
June	200,500	144,805	1,225,000	300,845	975,135	2,846,285
July	188,250	115,775	1,209,000	332,255	1,244,932	3,120,212
August	164,750	112,195	1,269,250	382,150	1,384,832	3,313,177
September	231,000	66,690	1,570,000	430,355	1,076,058	3,374,103
October	181,500	93,755	1,473,500	492,615	1,415,261	3,656,631
November	189,250	125,825	1,412,000	507,350	1,346,524	3,580,949
December	152,000	130,690	1,639,750	445,155	1,313,986	3,691,581
1913						
January	162,750	95,825	1,898,500	498,155	1,402,563	4,057,793
February	186,000	105,230	1,623,250	387,410	1,315,891	3,617,781
March	212,250	122,570	1,633,750	451,355	1,477,635	3,897,560
April	272,250	187,020	1,637,250	420,650	1,439,634	3,956,804
May	221,250	233,155	1,689,250	388,335	1,387,278	3,919,268
June	180,750	182,660	1,649,000	371,755	1,292,721	3,676,886
July	186,250	154,330	1,545,250	428,605	1,207,527	3,521,962
August	147,500	115,105	1,405,250	357,295	1,375,923	3,401,073
September	141,250	121,650	1,595,250	347,595	1,081,606	3,287,351
October	113,250	185,040	1,505,750	419,620	1,418,577	3,637,337
November	139,500	127,455	1,624,250	505,960	809,287	3,206,452
December	173,250	176,960	2,649,000	479,165	1,349,570	4,827,945

manufacturer has not been so well informed as the German about the future development of foreign business.

Table 2 is for comparative purposes only. It was made with the intention of finding an indicator for the foreign demand for foodstuffs, raw materials and manufactured materials. As in the first article, the English figures have been used for this purpose. The reason for doing so is that the free-trade market of England gives the best impression of the fluctuation of demand and supply in most commercial commodities sold in world markets.

It seemed quite possible that a demand for half-manufactured articles suitable for industrial purposes might in some way be reflected in the demand for metal-working machines. A close comparison of the monthly progress of the turnover in that class of goods, however, with the demand for metal-working machines as indicated in the last column of Table 1 seems to prove that this connection is rather incidental, and that the demand for such materials seems to rise and to decline in about the same way and during the same time as the demand for metal-working machines. This relation was already proved to some extent by the results obtained in the earlier article.

The thesis on trial is the connection between the demand for foodstuffs and like materials and the following demand for metal-working machinery. The best way to present the evidence is by a diagram; see diagram.

This diagram shows the development of the sale of metal-working machinery in the foreign markets, as ob-

TABLE 2. COMPARATIVE TURNOVER IN THE FOREIGN TRADE OF ENGLAND IN FOODSTUFFS, RAW MATERIALS AND MANUFACTURED GOODS—1911, 1912 AND 1913

	Foodstuffs		Foodstuffs, Total of Imports and Exports	Raw Materials		Raw Materials Total of Imports and Exports	Manufactured Articles		Manufactured Articles Total of Imports and Exports
1911	Imports	Exports		Imports	Exports		Imports	Exports	
January	20	2	22	28	4	32	13	30	43
February	17	1	18	24	4	28	13	29	42
March	20	2	22	23	4	27	15	33	48
April	19	1	20	18	4	22	13	29	42
May	20	2	22	18	4	22	14	29	43
June	21	2	23	16	4	20	13	29	43
July	22	2	24	15	3	18	13	27	40
August	22	2	24	14	4	18	13	29	42
September	22	2	24	16	4	20	13	28	41
October	24	3	27	21	4	25	14	34	48
November	26	3	29	24	4	28	14	31	45
December	25	2	27	25	4	29	14	29	43
1912									
January	24	2	26	27	4	31	15	32	47
February	20	2	22	24	4	28	14	29	43
March	20	2	22	24	2	26	15	34	49
April	21	2	23	24	2	26	14	27	41
May	21	2	23	18	5	23	15	29	44
June	21	2	23	15	4	19	13	27	40
July	24	2	26	17	5	22	15	32	47
August	24	3	27	18	5	23	16	34	50
September	23	2	25	18	5	23	15	33	48
October	28	3	31	25	6	31	17	37	54
November	25	3	28	29	5	34	15	33	48
December	25	2	27	31	5	36	15	32	47
1913									
January	22	2	24	32	5	37	16	36	52
February	20	2	22	27	5	32	15	32	47
March	21	2	23	22	5	27	16	33	49
April	23	2	25	22	6	28	16	33	49
May	23	2	25	21	5	26	16	35	51
June	24	2	26	18	5	23	15	33	48
July	26	2	28	18	6	24	16	36	52
August	23	2	25	16	5	21	15	35	50
September	25	3	28	19	5	24	16	32	48
October	27	3	30	27	6	33	17	35	52
November	25	3	28	27	5	32	15	33	48
December	26	3	29	28	6	34	15	32	47

tained from the English, German and United States statistics, compared with the development of the turnover in raw materials and foodstuffs represented by the total turnover of imports and exports in the English market. The upper long-dash line is the curve representing foodstuffs; the following full line represents the total English, German and American foreign trade in metal-working machines. The lower long-dash line represents the turnover in raw materials, while the lower full line shows the participation of American exports of metal-working machines in the total turnover of the years on record. The dotted line indicates the German exports during the same period.

The first of the three columns on the left side of the diagram, giving figures from 18 to 37, represents the total value of the turnover of the raw-material class in units of $5,000,000. The second column represents the total value of the foodstuff class at the same rate. The third column, running from 7 to 50, indicates the value of both the full lines in units of $100,000.

The close observer of the two upper curves will notice a certain connection between them. For instance the high mark of the foodstuff curve in January, 1911, finds

its counterpart in the rise in the sales of metal-working machinery in March, 1911. A second high point in the sales of foodstuffs is reached during March of the same year, which seems to be reflected again in the June and July sales of metal-working machines. From then on, the business in metal-working machines is fairly steady until the end of the year, which brings in December a high point with a sudden rise from the month of November. The diagram shows that this movement is fairly well predicted by a slow increase in the sales of foodstuffs until September, when a quick rise takes place in October and November, followed by a drop during December, which is promptly repeated during the next month in the sales of metal-working machines. The varying movements of the turnover of foodstuffs during the months of February to June, 1912, is followed by rather erratic changes in the turnover of metal-working machines, until foodstuffs begin suddenly to rise to a new high point in August. This later change becomes visible for metal-working machines in September of the same year. In the meantime foodstuffs decline again, sharply followed by a decline in metal-working machines two to three months later, but only to rise quickly to the highest altitude obtained up till then. Three months later, in January, 1913, we find metal-working machines climbing up to a record point.

Having followed the relative movements of both lines so far, it is not surprising that the sharp fall in foodstuffs beginning in November, 1912, brings about a drop in metal-working machines, until finally the increase in the sales of foodstuffs, beginning with August, 1913, and ending in another high figure in October, 1913, ends the year with a new high record in the sales of metal-working machines.

Little Value of Inquiry Into Raw Materials

Little of value for the present inquiry can be learned from a comparison of the metal-working machine curve with the one indicating the progress of raw materials for manufacture, etc. In fact the latter seems to move about in an erratic way, most likely influenced by speculative buying, and especially by such factors as the heavy buying of cotton during certain parts of the year, wool sales, etc. If there is a connection, it seems to be rather between the foodstuffs and the raw-material curve, whereby the latter appears to follow the first in about the same way as the demand for metal-working machines appears to follow that for food.

To facilitate comparison, two other curves have been added to the diagram, showing the respective participation of the United States machine-tool exports and those of Germany in the world's trade. There is nothing to be revealed by those two curves. The German exports as a rule are larger, but during the last few years this country has touched the German figures repeatedly and has even done better than Germany under certain conditions. The fact that the German curve as a rule follows more pronouncedly the demand for foodstuffs than the American seems to indicate that the German manufacturers have a better understanding of the hidden causes behind the demand for machine tools. But this may be a mere coincidence. Coincidence may also explain the peculiar likeness of the foodstuff curve and that of the American export curve during the months of July to November, 1912. Naturally one must be careful not to take everything which might fit into a theory as proof for it and these two points are better dismissed without further comment.

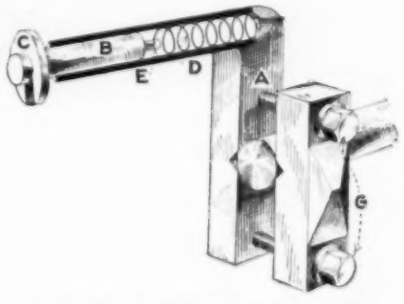
However, the contention that there exists a close connection between the sales of foodstuffs and the demand for metal-working machines seems supported by this investigation and appears to hold good even if applied to the much more rigid test of a monthly comparison. As far as can be seen, the reaction seems to take place about two to three months later. When we have a foodstuff-sale index figure of 36 in September, 1911, we have the figure 28 in November of the same year for metal-working machines. We then find a rising index figure for foodstuffs up to November, from 36 to 39 and ultimately to 40, while the index figure for metal-working machines climbs up to 31 or 32. The coming decline is also indicated in the same way by a decline in the index figure for foodstuffs in December, 1911, and January, 1912. During the first half-year of 1912 not much can be learned from the comparative movements of the two curves. A like combination of index figures might be worked out on several other different places.

Unfortunately there is insufficient material on hand to establish any sort of rule, if one exists at all, to indicate the size of a coming increase or decrease in the use of metal-working machines in relation to an increase or decrease in the output or demand for foodstuffs. It was pointed out in the former article that undoubtedly much unnecessary or uneconomic buying takes place, and that in consequence the turnover in metal-working machines often seems to be entirely out of proportion to the actual needs of the industry. This fact alone would prevent the discovery of a quantitative formula.

Device To Tie Center Work to Faceplate of Lathe

By A. A. Stucke

The illustration shows a clamp dog which I have used with success in machining operations on small tools or machine parts, such as boring a recess or other internal work where it is necessary to use a steadyrest tie strap. I find it a time saver, doing away with the troublesome



CLAMP DOG FOR CENTER WORK

tie which is often difficult to use when work is small and short. Then too the straps soon become oily and hard to tie. This clamp dog does away with these troubles. It is a simple operation to take the work out and replace it. Simply release the faceplate ⅛ to ¼ in., place the work in the rest and on center, tighten the

faceplate, and the spring in the hold-on dog does the rest.

To explain the device: The tail of the dog *A* is bored to receive the plunger *B*, which is grooved at the outer end for the slotted washer *C*. The spring *D* connects the plunger to the dog through the pin *E*. To attach to the faceplate, simply push the plunger through the faceplate slot and slip the washer over it; the spring then draws the dog and the work against the faceplate.

Interesting Planer Job

The planing of the inside bearing spots on printing-press side housings, as shown in Fig. 1, has proved interesting in several ways. The work is performed on a big Cincinnati planer, and an outline of the casting may be seen projecting over the edges of the angle plate against which it is bolted. A rectangular opening is provided in the angle plate to make room for the end of the extension tool used while planing. It will be seen that the work is very close to the heads when the tool is through the cut. In fact there is but ⅞ in. to spare. That the work was successfully performed proves the effectiveness of the planer reverse mechanism.

The tool used is shown on a larger scale in Fig. 2. To hold the extension tool, a hole was drilled through the lower end of the regular clapper block and countersunk at the back. The extension block used had in one end a stud that was fitted into the hole drilled in the clapper block. A nut in the countersunk hole held the extension block at any angle desired. A small clapper block set into the end of the extension block carried the cutting tool and allowed relief on the return stroke.

Improvised French Curve

For scribing master cams, irregular dies or similar work a coil of clock-spring steel, about ⅝ in. wide, and from 0.015 to 0.030 in. thick is a helpful tool. It is as useful and convenient as a French curve, according to the experience of John Huntting.

When the inner end of the coil is clamped to the other coils close to its extremity, a practically perfect circle of any desired diameter may be obtained, while clamping longer or shorter strips of stiff metal inside of the coil will yield almost any irregular curve ordinarily desired.

Novel Use for Dynamite

Somebody bobs up almost every day with a new idea for the advantageous use of dynamite. The *Du Pont Magazine* tells of a question received in a letter from a Nebraska blaster, who asks, "You wouldn't think a man could use dynamite in rebuilding a steam engine, would you?"

He then goes on to explain that he is an engineer by trade, that he has always had a lot of trouble in removing keys from pulleys, but that his troubles are now over because he has discovered that he can jar a tight key loose simply by placing a teaspoonful of 40 per cent. Red Cross dynamite against the end of the key, mud-capping the charge and letting the dynamite do the rest in very short order.

Of course care would have to be exercised in placing a charge of this kind to avoid breaking the pulley or the key.

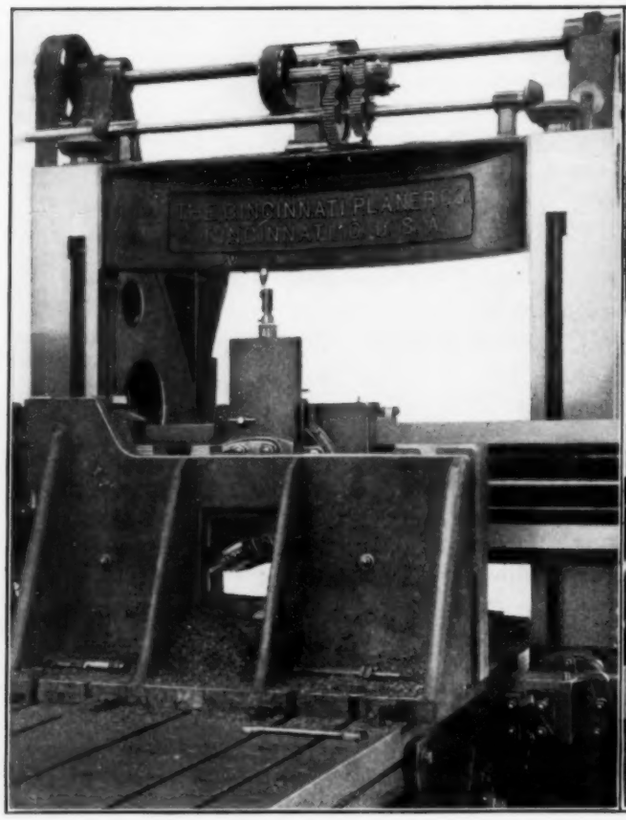


FIG. 1. PLANING BEARING SPOTS ON HOUSING

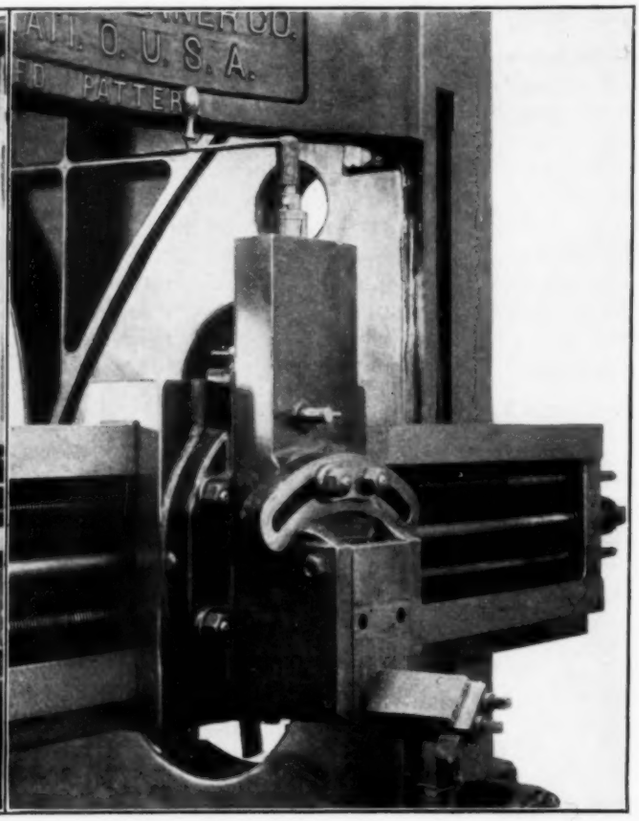
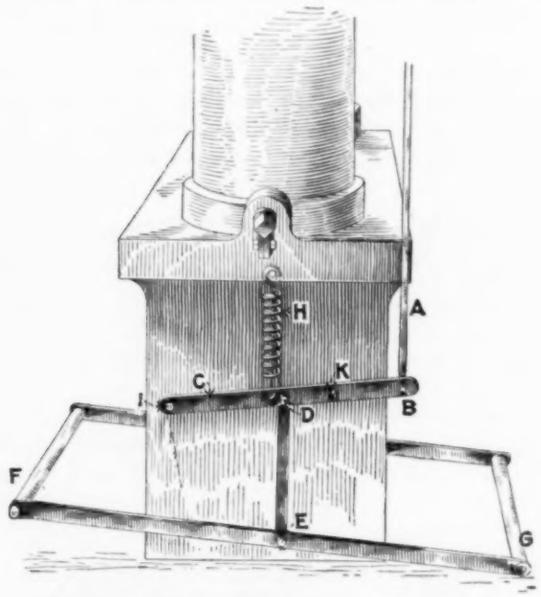


FIG. 2. THE SPECIAL EXTENSION TOOL USED

Letters from Practical Men

Drop-Hammer Safety Trip for Two-Man Operation

There are some kinds of work in which it is necessary to work the hammerman on one side of a drop hammer and his helper on the other. To avoid possible injury to the helper, the hammerman, before tripping the drop, has to look and be sure that the helper is clear. One day while watching a job requiring this arrangement, I schemed a simple change in the pedal and linkage which allows either the hammerman or his helper to prevent the starting of the hammer, or after it has been started permits either to stop it at the end of its stroke.



DOUBLE SAFETY TRIP FOR A DROP HAMMER

In the illustration *A* is the trip rod, operating downward to start by pressure through the joint *B*. At *C* is a lever, fulcrumed at *I* and connecting through the link *DE* to the treadle frame. This frame nearly balances around the point *E*, being slightly heavier on the helper's side, so that his pedal normally rests on the floor. A coiled spring *H* carries the weight of the treadle and linkage.

In operation the work is put in the die, the helper putting his foot on the treadle at *G*, and the hammerman steps on *F*, bringing down the hammer. Should the hammerman press his side of the treadle too soon, he would only succeed in raising the side *G* off the floor, the helper not having placed his foot on it to hold it down. As soon as he is ready, the helper depresses *G* and starts the hammer. Either can hang the hammer up at the end of the stroke by lifting his foot, although the helper should do this only in an emergency, the control being normally with the hammerman.

An advantage not originally looked for is the ease of changing the control for one-man operation from one side of the hammer to the other by hooking either *F* or *G* to the floor. The control is on the opposite side. For hammers operated by an upward movement of *A* the only change necessary is to move the fulcrum of the lever *CD* to *K*. The lever then becomes *DB*, with its fulcrum at *K*.

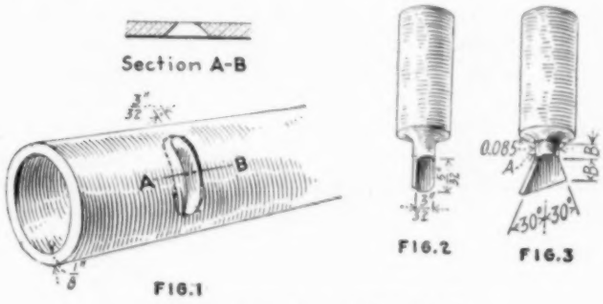
HARRY W. JOHNSON.

Poughkeepsie, N. Y.

Undercutting a Tube Slot

It is sometimes surprising to find what simple answers can be found to problems which at first seem very difficult. Almost anyone can do a hard piece of work with elaborate fixtures and plenty of time to get ready, but the real test of a man's ability is in getting equally good results by a shorter method.

As an example of this, a job of undercutting some slots in a brass tube, as shown in Fig. 1, comes to mind. These slots were near the middle of the tube and were impossible to reach from the inside. They were also too narrow at the top to admit of the use of any ordinary cutter by dropping in and milling one side at a time, and as there was a large number of them filing was out of the question.



UNDERCUTTING A TUBE SLOT

The slots were first cut through straight with an end mill, as shown in Fig. 2; a two-lipped cutter, Fig. 3, was dropped down through while the cutter was standing still, then raised up carefully after the mill was started. This cutter head had a shank at *A* slightly smaller in diameter than the width of slot already cut, and a length *B* about $\frac{1}{32}$ in. more than the thickness of the wall of the tube. The tube was then revolved past the cutter, giving a good finish and getting the job out in record time, as both sides were beveled at once.

M. V. DECKER.

Rochester, N. Y.

Grinding Die Setting-Pins

In most good shops dies are fitted with setting-pins. In order to grind their entire length accurately, a shank is usually turned at one end to accommodate the carrier, as shown in Fig. 1.

Fig. 2 shows a simple and effective method of grinding setting-pins and similar work without the aid of a

shank or carrier. The center marked *A* should be at least twice as large as *B*. Center *A* is placed on the live center of the grinder, and the tail center of the grinder is set so that the live center will carry the work with it, owing to the friction being much greater at center *A* than at *B*.

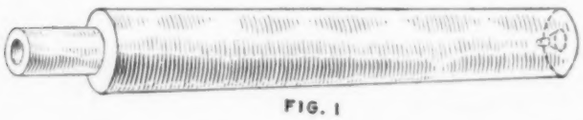


FIG. 1

FIG. 2

DRIVING PIN WITHOUT EXTENSION

A little chalk rubbed on the live center of the grinder will increase the friction. Center *B* should be well oiled. It is surprising what fairly heavy grinding cuts may be taken in this way.

JACOB KIRCHMER.

Brooklyn, N. Y.

Assembling Stand for Automobiles

The International Motor Co., Saurer Plant, Plainfield, N. J., has designed and is using in its motor-assembling department an interesting erecting stand. One of these stands, with a motor unit in position, is shown in Fig. 1.

The support *A* is first fastened on the crankcase with bolts. The motor unit is then dropped into the erecting stand. The starting crankshaft passes through a slot *B* and sets in the bearing *C*. The support which carries the rear end of the unit has two turned gudgeons, which rest in bearings as *D*, one on each side. The flange *E* is fitted with eight holes, into which is set a plunger forced down with a spring and cam operated by the handle *F*. This arrangement permits the fixture holding the unit to be swung around with the handle *G* and held in eight different positions. Details of this stand are shown in Fig. 2.

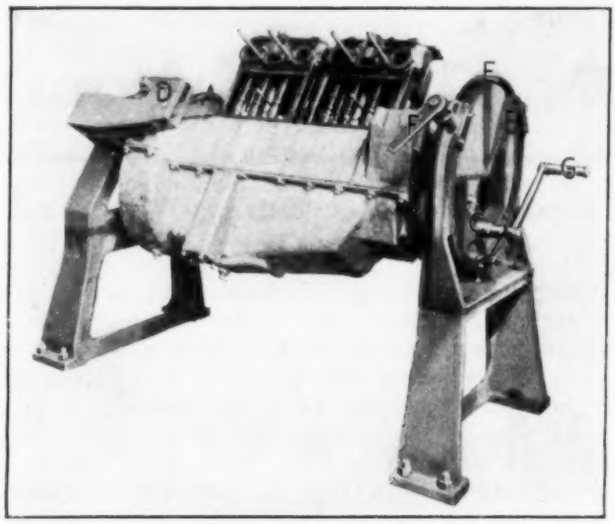


FIG. 1. ASSEMBLING STAND FOR MOTORS

2. The handle and cam arrangement is shown at *A*. This stand has proved very useful in service, a number being employed in the motor-assembling department.

New York City. A. TOWLER.

A Shaper Tool Block

The illustration shows a tool holder, or block, which I have found very successful on different shapers in place of the usual clapper block provided for tools. It takes the place of the usual clapper, the same pin being used in both cases.

It will handle almost any size of forge tool and will also handle light work very satisfactorily. A setscrew on the side at *A* and two on the top at *B* serve to hold the small angle block *C* firmly in position against the tool *D*. The dimensions shown are those which have proved very successful in my own case.

At the back of the holder is a steel plate *E*, which is inset and screwed flush as shown. This takes the end thrust of the tool.

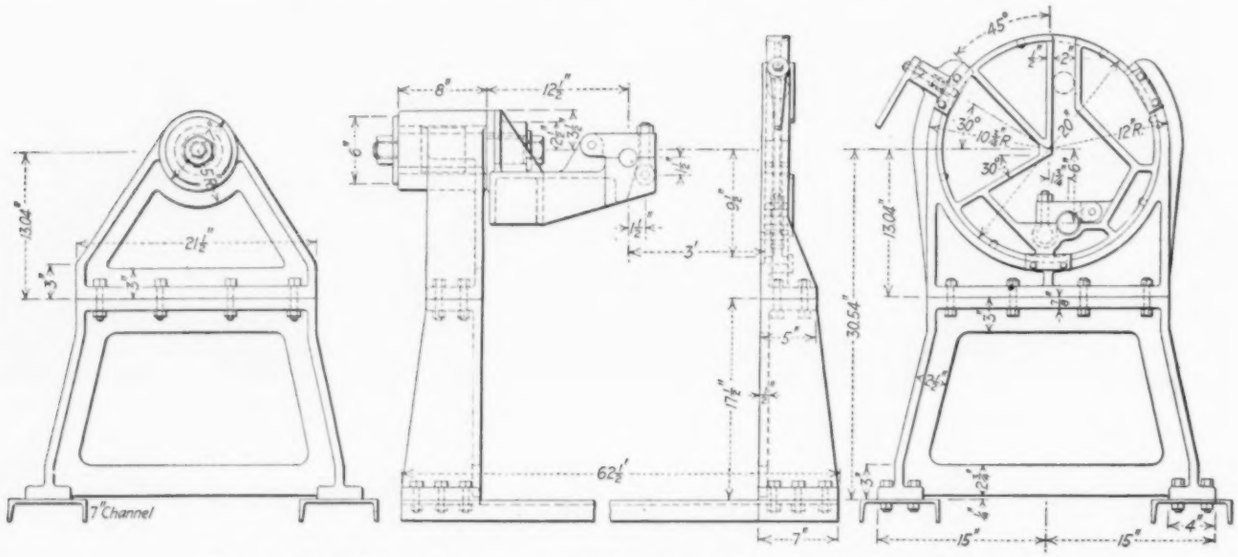
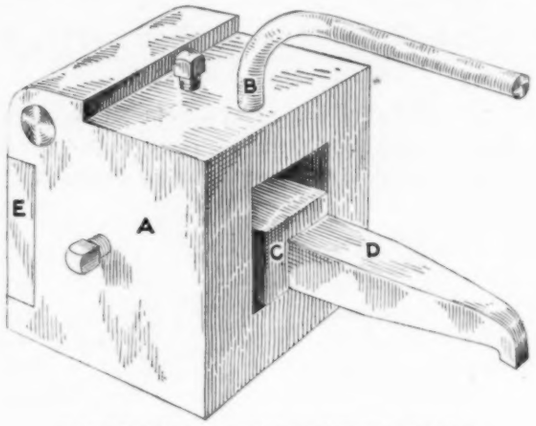


FIG. 2. DETAILS OF HANDY ASSEMBLING STAND FOR AUTOMOBILE MOTORS

To hold the tool down when taking a cut, a hole was drilled in the top and a $\frac{5}{16}$- or $\frac{3}{8}$-in. rod put in and then bent to a horizontal position. This gives a good leverage, and the operator simply lays his hand on the



HANDY HOLDER FOR SLOTTING TOOLS

end of this rod, which holds the tool down in position while light cuts are being taken. This device has proved very satisfactory in our shop. R. W. CRAGIN.

Brookline, Mass.

Making a Small Rack and Rolls

In Fig. 1 is shown a 94-pitch rack, of 0.032-in. brass $\frac{3}{32}$ wide and 1 in. long, which was to be made. Not having a milling machine, we devised the following method.

The brass was cut to length and width, the pieces placed side by side on edge on a steel block $\frac{3}{8}$x2x4 in. and sweated in place. The tool post was removed from a small lathe and the steel block fastened down on the slide

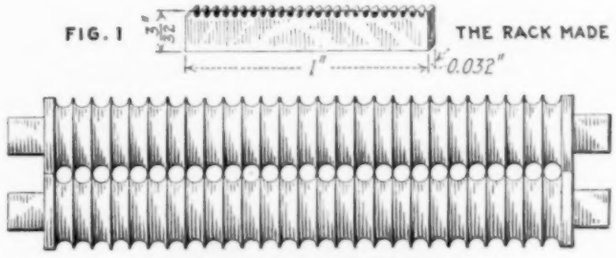


FIG. 2 THE STEEL ROLLS

MAKING A SMALL RACK AND ROLLS

rest, the longest dimension at right angles to the shears and parallel front and back. A piece of 1½-in. cold-rolled steel was swung between the centers and driven by a carrier. A fly cutter was inserted and held in place by a setscrew.

The cutter was made of ½-in. drill rod and formed to cut over three teeth of the rack. The first tooth blocked out, the second roughed and the third finished. The advance of the rack was figured out in thousandths. The intermediate gear and the gear on the lead screw were removed, and from the rack was selected a gear which had the correct number of teeth to give the proper advance of the carriage. A spring attached to the end of the lathe, engaging the teeth of the gear, served as an index. The depth of the cut was obtained by adjusting the cutter in the bar. The carriage was brought into position for blocking out the first tooth and clamped to the lead screw, the crossfeed to the back of the lathe so that the work would feed against the cutter.

After the first tooth was blocked out across all the pieces, the gear was turned, counting the teeth as they passed under the spring until the predetermined number had advanced. The next cut was then taken, blocking the second tooth and roughing the first. The next operation finished the first tooth, and each succeeding operation produced a finished tooth in each of the hundred racks mounted.

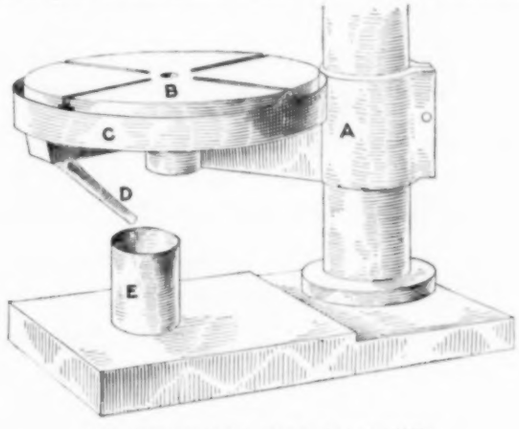
We recently had occasion to use the same method on another class of work—two steel rolls, Fig. 2, ¾ in. in diameter, 4 in. long, with semicircular evenly spaced grooves ⅛ in. wide, $^{9}/_{64}$ in. from center to center. The two rolls were geared together and supported so that the edges of the grooves just touched one another. It is evident that any variation would be intolerable. At each advance of the lead screw the tool, a semicircular former ⅛ in. across, was fed in $\frac{1}{16}$ in., using the micrometer on the crossfeed to get the depth of cut. This method produced the two rolls identical in spacing, the edges being perfectly aligned. R. BURTON WHITESIDE.

Philadelphia, Penn.

An Oil Reservoir for Machines

The illustration shows, fitted on a drilling machine, a simple device for catching oil or cutting compound.

The ordinary support on the drilling machine for carrying the revolving table is shown at *A* and *B*. A circular pan *C* was made about 2 in. deep, a little larger



OIL RESERVOIR FOR MACHINES

than the table, and a hole was cut in the bottom so the shank on the bottom of the table could extend through the hole in the bottom of the pan and down under the pocket of the machine arm. The shoulder on the bottom of the table clamped the pan securely against the face of the arm. By soldering a little pocket on the bottom of the pan a lead pipe *D* extended from this inwardly to near the center. The bucket *E* was set under the center of the table. Whatever lubricant ran down through the center hole went directly into the bucket, and what ran over the edge of the table was caught by the pan, led into the pocket on the bottom and conducted by the pipe into the bucket.

We were also troubled in the same way by an old-fashioned milling machine and adopted a similar scheme.

Portland, Ore. E. P. ARMSTRONG.

A Neat Recessing Tool for Percussion Caps

A recessing tool that is simple in construction and that can be easily kept in good working condition is shown in the illustration. It was designed for forming the recess for the cap chamber in the Russian percussion cap.

For such a recess of a width of about 0.040 in. a left-hand spiral with a lead of approximately 3 in. on a ¾-in. diameter should be given. This spiral is cut for only half a revolution, which revolves the cutter holder *A* the full throw of the eccentric.

Owing to the fact that the cutter is revolved through pressure on its end, no clearance should be given at this point. This feature enables the tool to cut a recess at the

RECESSING TOOL FOR PERCUSSION CAPS

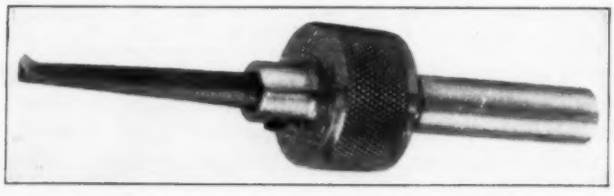
extreme bottom of the hole without any stop being used, and also to burnish the bottom of the hole as well as to press out any teat left by the previous tool.

The tool is equally adaptable for use in a lathe, hand-screw machine or drill press. When used in a drill press through a jig, it can be actuated through pressing on the bushing instead of on the cutter itself.

Mount Vernon, N. Y. R. F. Nowalk.

Simple Boring-Tool Holder

The illustration shows a boring-tool holder which is both simple and efficient. The holder body, which has a taper shank to fit the milling-machine sockets, is 1⅛ in. in diameter, ¾ in. long and has a hole $\frac{13}{16}$ in. Into this hole is fitted with a good fit a plug $\frac{13}{16}$ in. in diameter



A SIMPLE BORING-TOOL HOLDER

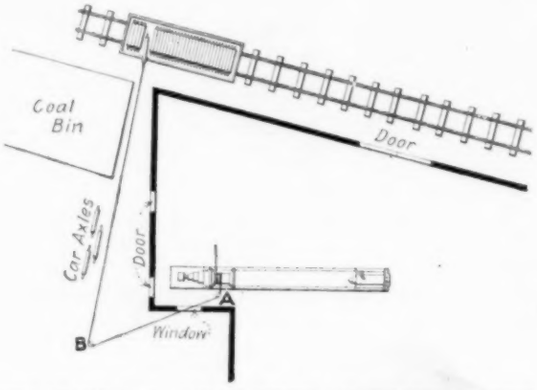
and 1⅛ in. long, which may be locked by the headless screw shown.

The outside of the plug is then trued up, and a $\frac{5}{16}$ in. hole is bored and reamed through the plug and about $\frac{1}{16}$ in. into the body, so that when a $\frac{5}{16}$-in. boring tool is inserted to the full depth of the hole it will automatically bring everything perfectly true. The protruding eccentric part of the plug is turned down to ½ in. in diameter and flush with the end of the body. The plug is graduated halfway around and two zero marks placed on the body. A No. 10-32 screw in the turned-down part of the plug is sufficient to hold the boring tool used.

Brooklyn, N. Y. Oscar Halvorsen.

Unloading Car Axles with an Engine Lathe

I had a carload of car axles to unload, and as the space was limited they had to be unloaded endwise. So I rigged up a 20-in. lathe in the manner shown herewith.



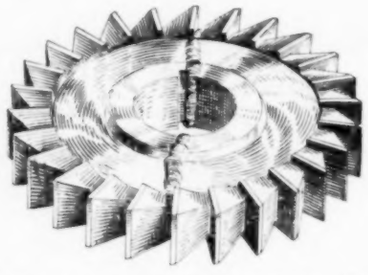
UNLOADING CAR AXLES WITH AN ENGINE LATHE

I chucked a capstan head in the lathe and ran the rope over two small sheaves *A* and *B*. In a short time I had the car axles piled all around. Perhaps some others may be able to use this method to advantage.

Beaumont, Tex. F. A. Lincoln.

Unusual Autogenous Welding Tool Job

During one of the milling operations in very hard metal two side mills used for straddle-milling broke in halves. The four halves were sent to a local autogenous welding shop and welded together. The superfluous metal was then removed on the grinder and the cutter reground.



UNUSUAL AUTOGENOUS WELDING JOB

The size of the holes was not materially changed by the welding. One of the cutters after welding is shown in the illustration.

These mills have been in continua, use for nearly a year, and so far they show no signs of weakening, although used for straddle-milling tough forgings. As these cutters were of high-speed steel six inches in diameter, the saving was a considerable item. No heat-treatment was required.

Worcester, Mass. John R. Matte.

Discussion of Previous Question

Lubricating Lathe Centers

I have been much interested in the discussion pertaining to successful lubrication of lathe centers. My experience coincides very closely with that of Charles C. Steward, as expressed on page 1131, Vol. 43—that is, first, large centers in the work, then the oil grooves. We use three instead of four, having found that this number gives better results. They are made with a punch in the same way as described by Mr. Steward.

For straight work we use the finishing punch described by Mr. Steward, but for work that is turned taper by setting over the tailstock we use a finishing punch that has an angle of 58 deg. at its point, increasing to a 62-deg. angle at its largest diameter. This makes a center in the work that seems to fit the lathe center somewhat better, but is far from perfect. Then to avoid the uneven wear that inevitably takes place in the work centers, we loosen the driving dog at regular intervals, rotate the dog about one-eighth of a turn and clamp again. By carefully following this plan, we get very satisfactory results.

We have not found anything else equal to the mixture of white lead, graphite and oil for a lubricant.

Watervliet, N. Y. MARTIN H. BALL.

Cutting-Off Swage That Did Not Work Well

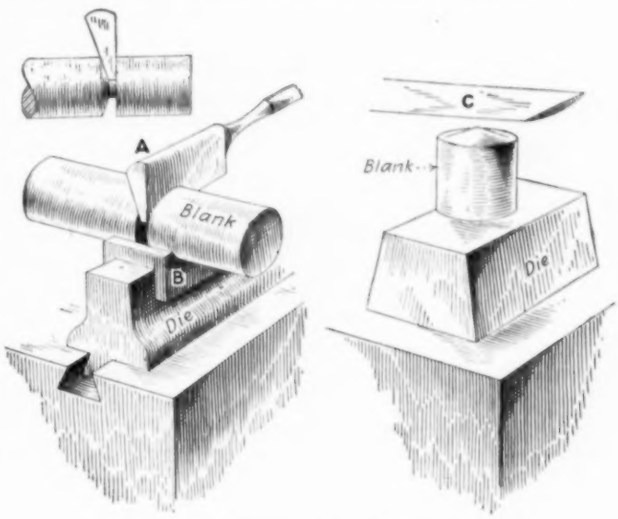
The article on swages, on page 856, Vol. 43, leads me to comment on the subject of cutting off pinions or round pieces under the steam hammer. I ran up against this proposition years ago and have not seen or heard of any tool that would cut a hot billet or shaft in two without leaving one end full in the center.

Under the steam hammer the billet must be cut with a cutter, as shown at *A* in the illustration. The taper of the cutter causes the meal to crowd out on both sides or on one side, depending on how the hammersmith holds his cutter. Holding it upright makes both sides full in the center; holding it slightly on an angle brings the fullness on one side only. The cutter is slightly rounded on the back, so that it can be held upright or at an angle either way.

It is also unnecessary to have such a tool as Mr. Hunter describes, with a plain bottom swage, loose fitting on the bottom die, as at *B*. Keep the blank round, hold the cutter right, and have the helper turn the stock at every blow. It will be soon cut off, but only one end will be square.

As to the weight of the blanks, Mr. Hunter must not expect to get them accurate. I think the hammersmith is doing reasonably well in getting the stock to correct size. By watching his lengths and cutter, the smith can perhaps come within one or two pounds of the estimated weight. But where the measurements are not too close he will forge three pieces to one with close limits. Consequently the cost of a pound or two of steel does not matter much.

The full end on the blank is really of no importance, as the smith can overcome it with a few hammer blows. Stand the blank on the die square end down, and with a piece of half-oval steel, as at *C*, spread the full end with a few light blows, turn it down, round it and it is done.



FLATTENING FULL END OF HOT BLANK

The reason for using the half-oval steel oval side down is to cause the forging to spread at the extreme end, so that the body of the forging is not changed. The blank should be turned round at every blow, and the blows should be light. GEORGE COLES.

Decatur, Ill.

Electric Arc Welding as a Practical Shop Method

The letter by Mr. Miller on p. 694, Vol. 43, is of more than passing interest, because it shows very clearly the importance of judgment when applying modern welding processes. It was therefore with interest that I perused it, particularly regarding the emphasis given to the words "when rightly applied," which undoubtedly apply equally to all methods of welding. It is well known that modern methods of obtaining high temperatures for welding by means of gases and electricity have greatly extended the scope of welding. However, it must be borne in mind that each system has its own particular spheres of applicability to which it should be confined, if maximum technical efficiency and commercial economy are to be secured. Therefore they should be rightly applied, as no system of welding is universally applicable, technical or commercial limitations, or both, being inevitably encountered sooner or later.

In the hands of a skilled welder, and apart from questions of cost, the distinction between oxyacetylene and arc welding lies in volume and degree of heat. For instance, the oxyacetylene flame, owing to its lower tem-

perature, is regarded as better for thin work than the electric arc, because the risk of burning the metal is not so great. In other cases the electric heat is perhaps more effective, because it is produced within the work itself, whereas the heat of the oxyacetylene flame is applied entirely from the outside. Where work is suitable for the electric arc, welds can be made far more quickly than by the oxyacetylene flame.

The special case quoted by the author of the letter referred to, regarding the welding of high physical quality alloy steels, is a concrete example of the absolute necessity for the welding operator to have the needed knowledge of the changes that take place in the structure of the metals under the action of the flame. As these high-quality steels are constitutionally scientific alloys, they demand scientific treatment. In this respect it is customary to find the average welder lacking the required knowledge. It may be of interest to mention that recent investigations have shown that only a few degrees of variation in temperature make considerable difference in the hardness, elastic limit, reduction of area and longevity of these steels, as shown by fatigue tests.

For instance, steel heated 50 deg. F. above the transformation or critical point shows a loss of something like 15 per cent. in these physical properties. Greater variations show correspondingly greater losses, hence the necessity for care when effecting welds on these metals. In minor cases, such as welding tool stub ends to softer bodies, this may be advantageously carried out. Generally speaking, however, it is advisable to abstain from applying welding processes to high-quality steels except where the strength of the welds is not important.

Again, I have known innumerable instances where these welding processes have been incorrectly applied owing to lack of knowledge in designing the work to be welded. It should be thoroughly understood that to weld properly and to make the weld sound throughout, a certain amount of skill and experience is required together with knowledge of how and where to apply the system, as well as how to design and prepare the work being welded, no matter whether electric arc or flame welding be used.

The employment of unskilled labor in operating modern methods of welding is another source of unsatisfactory welds. This is due to a great extent to statements made by salesmen anxious to sell their firms' apparatus, whose remarks are generally to the effect that it is not necessary to employ a skilled man to operate their equipment and that good welds can be obtained with simply a few hours' practice. As a case in point: Some time ago I contemplated the welding of aluminum sheets for arch roofs of cars. Several welding-equipment manufacturers were consulted as to the most suitable equipment, method of effecting the welding of the joints, costs, etc. Sheet aluminum, 0.080 in. thick, was the material used. The roofs were approximately 60 ft. in length and 9 ft. in width. The dimensions of the sheets were 12 ft. in length and 5 ft. in width. The sheets were first formed to the desired curvature, butted together lengthwise, then riveted to steel sections, the pitch of the rivets being about 10 in. The sheets were riveted both to secure them to the steel structure and to keep them in position during the welding operation.

Experienced welders will without doubt readily observe that the welding operation was of a somewhat difficult nature, mainly because the sheets were simply butted together on the cold-steel structure and became restrained members of the structure. Thus internal stresses were rapidly set up in the metal. Nevertheless, the following is a statement which we received from one of the welding firms regarding the operator to work its equipment: "It would be best if you would choose a man who has had no experience in welding, as it is much easier to teach such a man the right way of doing the job than another who has perhaps some idea of welding and thinks himself an experienced welder, but only practices wrong methods."

This suggestion was not entertained and an experienced welder was employed, who welded all the joints, approximately 200 ft. of welding. This was done at the rate of about 12 ft. per hr. Although the work was executed fairly satisfactorily, for various reasons, the design was unsuitable to secure perfect results. The internal strains set up were not only sufficient to crack the metal in the line of welding, but distortion of the sheets was very great. Penetration at the weld was not uniform, and traces of the welding flux on the under side of the weld could not be removed and caused subsequent rapid corrosion of the metal.

Many analogous cases may easily be described where unsatisfactory welding has taken place due solely to lack of knowledge in designing the work prior to welding. Therefore the necessity for judgment to apply modern welding processes only where proper results can be secured.

A. EYLES.

Manchester, England.

Useful Relation Between the Squares of Numbers

Mr. Olds' article, Vol. 43, page 1126, on "Useful Relation Between the Squares of Numbers" calls to my mind a trick which I have long used for squaring a number which is adjacent, or at least near, to a number whose square is known. It is simply that the difference in the squares of any two numbers is equal to the product of their difference and sum, which is expressed by the well-known algebraic formula, $a^2 - b^2 = (a - b)(a + b)$.

Thus it is easy to obtain the square of 28 mentally, as follows: $30^2 - 28^2 = 2 \times 58 = 116$. As the square of 30 is 900, the square of 28 is at once seen to be $900 - 116 = 784$.

The rule is very simple for adjacent numbers. Thus 39^2 is less than 40^2 by $39 + 40$, or 79. As 40^2 is 1,600, 39^2 is 1,521.

WILLIAM O. MILTON.

Franklin, Penn.

Miller Designer and Shop Superintendents

On page 10, Vol. 44, E. P. Armstrong has an article that calls out a piece of history; and as it gives me a chance to blow my own horn—a chance I am looking for—I will proceed. If the editor does not throw this in the waste-basket, he becomes jointly responsible.

Mr. Armstrong calls attention to the common practice of making short the guide in which the table of a miller travels. A maker of millers can say—and if questioned

about it will say—"I have always made them that way; everybody makes them that way. I can sell all I can make, and why change?"

In *Engineering* some time in 1872, or 1873, there was published a cut from a photograph showing a miller with the slide and guide of equal length. While it could not be set at as great an angle as the short guide, it would swing to the angle necessary to flute twist drills made on it. I believe at least a million twist drills were fluted, and yet the slide never wore enough so that the slack was ever taken up. I can prove it, as the machine was built in 1863 and for the first 25 years it was used for making twist drills and regular shop work—and I still have the machine.

This history goes far to confirm the statement that the thing that does not wear out of true does not wear much. No one, so far as I know, has copied this idea, but now after 50 years, Mr. Briggs, the mechanical engineer for the Smith-Premier Typewriter Co., tells me he is designing a machine and is using such a slide.

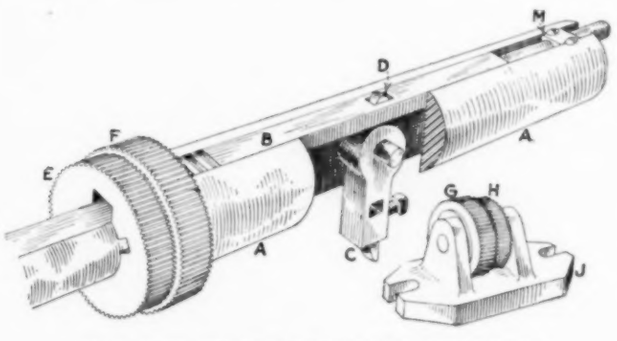
Mr. Armstrong mentions the lack of superintendents, or of men suitably trained for superintendents. Start by instilling into the minds of bright young men the principle that the men who work with their heads get better pay than the men who use only their hands.

Syracuse, N. Y. JOHN E. SWEET.

Machining Spherical Bearings

The shop foreman who is keen must ever be on the lookout for methods of tackling prospective jobs. While spherical bearings may not be part of his work today, they are sufficiently common in present-day design to interest every shopman in methods and tools for their production. For this reason I read with interest the article by J. A. Moffatt, page 816, Vol. 43, on machining spherical bearings.

The boring bar described is ingenious but would be costly to make and has several weak points. Having had several disappointing experiences with bars that use a rack for actuating a tool, I decided not to use the rack again if it were possible to design any other method. The



BAR FOR BORING SPHERICAL BEARINGS

trouble with the rack is that, however well it may be made, backlash between the teeth will sooner or later cause trouble.

In the bar shown by Mr. Moffatt, the method of carrying the star wheel and the gear wheels that actuate the rack seems cumbersome; and as the bar turned they would be apt to catch the operator's clothes. Apart from this, the star feed is not to be recommended on spherical work, as it leaves a small ridge where the feed jumps on.

A simple way of actuating the swinging arm of a bar for boring spherical bearings is shown in the illustration, which shows an existing tool modified to suit Mr. Moffatt's type of bar. Here *A* is the main boring bar and *B* the sliding bar that moves the tool holder *C*. Bar *B* is slotted at *D*, and the tool holder fits this slot, being rounded to work freely without backlash. As both pieces may be hardened, this design is durable and gives a better action than a rack.

The end of bar *A* is turned down to take gear wheels *E* and *F*, which differ in diameter. The wheel *F* has a square thread cut on its inner diameter which engages with a corresponding thread cut on bar *B*. Wheel *E* is slotted to allow bar *B* to work through it and is keyed to boring bar *A*, thus securing wheel *F* in place. The feed is obtained by means of two gear wheels *G* and *H*, shown mounted on a small bracket *J*. Wheels *G* and *H* are fastened together but are free to revolve on the pin.

In action the bracket *J* is fastened to the saddle of the boring machine in such a position that wheels *E* and *F* gear with pinions *G* and *H*. Consequently when the boring bar revolves, wheel *F* will revolve at a different rate from wheel *E*, with the result that the square thread inside wheel *F* will move bar *B* and with it the tool. The feed may be changed for different diameters of work by changing the ratio of the gears.

When a cut has been taken, bracket *J* is drawn back to disengage the wheels, and wheel *F* is turned by hand to return the tool holder to its starting point. Should the number of pieces to be done warrant the extra expense, bracket *J* could be designed as a swinging quadrant.

The bar *B* is held in position in the slot in a small bearing, as shown at *M*, at the end opposite the gear wheels, but could be held equally well by a cover plate.

Having used this method of feed on several occasions, I can recommend it not only for its smoothness in action, but because of its adaptability.

Guildford, England. WALTER G. GROOCOCK.

Machinist Instruction in the Public School System

I agree most heartily with George Heald regarding the time element, as it enters into machine-shop instruction in public or vocational schools, when, on page 122, he says: "Personally I believe that quality should be the foremost consideration, but the time element should always be present. The more a boy does under adequate instruction during the course the more efficient he will be when he graduates."

Time is money, and if left to themselves, almost all boys are millionaires and would soon bankrupt any firm by their spendthrift habits. It then becomes the duty of the trade school to teach the value of time as thoroughly and impressively as it can. Speed, however, is not the first essential. There are many other things to learn first, and on the correctness of the first instruction in manipulation often depends the future rate of the boy as a workman. A correct method, used repeatedly, develops speed of its own accord.

As we get accustomed to doing certain things, they become more and more automatic with us, until we do

them unconsciously and, if the occasion requires, with incredible speed. It follows then that speed is obtained through repeated drill in similar operations, not necessarily performed at a high rate of speed. Accuracy is generally conceded the first place of importance in the beginning of instruction and is usually associated in one's mind with slow, painstaking work. And so it is at the start, but here again familiarity, obtained by more repetition, gradually increases the speed.

In our shop, where the boys put in 7 hr. a day, we expect them to keep busy and stay at their machines just as in a commercial shop, and they do that just so far as we can make them see the necessity for so doing.

Very few people work for any other reason than because they have to, in spite of all the contrary mottoes that they stick up. It is necessity that drives most of us, and we respond according to our various ambitions.

Now, boys are not much different, and they respond to just the same forces. They are concrete-minded creatures, and abstract problems do not appeal very strongly. To tell a boy that he must work faster, because if he was working in a shop and didn't, he would get fired, is not a particularly strong argument. He will listen and agree with you, but as long as he isn't going to get fired right off, he speeds up only a little.

You may try the other tack with him and attempt to demonstrate that his trade is like a bank account and, figuring back from his future salary, show him how much each hour in the shop is worth to him, but remember that you are dealing with a millionaire, and do not be disappointed if he scorns such paltry amounts.

Pride, rivalry and competition will do much to develop rapid workmen out of boys. A desire to beat someone else's record will do more than repeated scoldings and is a bigger appeal to boy nature than the idea of future requirements ever will be.

Any manufacturer who visits your school will invariably tell you that, above all, you must teach your boys to be rapid; that today, owing to the war, high cost of living, heavy taxes, and high cost of labor, employers must get a lot out of a man, if he is to be worth anything to them. True, but he also expects a lot of other things that he doesn't mention, and he gets them as a matter of course. If you bring a certain type of man into a school of this sort and show him your equipment, he will immediately begin to figure how much work you can turn out with it, forgetting that the finished product of this particular shop is not machinery, but machinists. It must not be forgotten either that this training is a natural process and that the speed part comes near the end.

Plant a bulb in a pot and put it in the dark. At the end of six weeks there has apparently no growth taken place; yet if you invert the pot and allow the contents to drop into your hand, you will find that the root growth is remarkable, though where the ordinary observer would look for results, there are none. The same thing applies to the boy. While on the surface he is apparently dormant, in spite of attention and instruction, if you have the faith of your observation and experience you will know that this is not so. The rapidity of his development at a later period will astonish you.

Therefore, knowing this and believing in it, I can say that we do not worry a whole lot about the actual speed as long as the boy keeps busy and does not waste his time or allow his machine to stand idle. I have the utmost faith in the boy and believe that when he goes to work he will respond to the call of necessity with the same alacrity shown by the rest of us, and with the same degree of cheerfulness and success. And this faith is based on the fact that I have seen boy after boy go out and make good.

BURTON A. PRINCE.

Westfield, Mass.

A Sharp Deal and What It Cost

On page 1106, Vol. 43, Mr. Godfrey, in his usual interesting manner, sets forth the details of a sharp deal and reminds us that revenge is not always sweet. Sometimes there is a better way of beating a man at his own game than telling him to go to ——.

I am reminded of a case where Mr. Manufacturer sold Mr. Customer a couple hundred of a certain fixture with patented features. This was specified by the engineer in charge as being the best for the purpose. The customer was sore from the start, for he did not like being restricted in his buying. So he tried to get even. The whole transaction amounted to about $500. When the check was received, there accompanied it a letter stating that the articles had been made wrong and a deduction covering labor expended had therefore been made from the invoice.

Inasmuch as the articles were used in the same city in which they were made, Mr. Manufacturer felt aggrieved that he had not been notified and either permitted to make good or prove there was no mistake. Like Mr. Builder, however, he swallowed hard, sat back and awaited his inning.

It came. Mr. Customer had to apply for another lot. He was politely but firmly told that before a single wheel would turn on his order he must come across not only with the balance withheld on the previous sale, but also a check covering the new order. In this case nobody lost. Mr. Customer was not deprived of his needs, and Mr. Manufacturer maintained the respect that one man always gives another for ability to protect his own interests.

H. D. MURPHY.

Jersey City, N. J.

Suggestions from Employees

Regarding the unfair manner in which suggestions from employees are treated, I have learned from observation and my own experience that it is not safe to make suggestions unless you are prepared to move or unless you give them to someone to use as his own ideas. Petty officials seem to think that the firm should not be allowed to profit by anything which does not reflect credit in their direction.

Some time ago I was working in a factory which was way out of date. Seeing many chances for improvements, I mentioned them to the assistant foreman, who was also the draftsman. As usual the ideas were ridiculed and apparently killed. Later I learned that they had all been worked out and found O.K., the credit going to the draftsman.

I have just read Charles Gutman's article on page 78 and quite agree with him that the suggester's name should be kept secret from the general foreman and others. I believe that the suggestions should go direct to the office of the manager or president.

W. J. WELLS.

Brooklyn, N. Y.

Editorials

A Beneficial Effect of High-Speed Steel Scarcity

High-speed steel is scarce. The general situation caused by its enormous demand, limited supply and high price can only be viewed as a hardship to the machine shop. For there never before has been a time when production was so vital to the American metal-working industries as it is today. Suggestions for relief are many and come from various sources. On page 110 the use of molybdenum in place of tungsten as an alloying agent was advocated. On page 123 of last week's issue and in a following discussion on page 165 of this issue are shown several methods for attaching high-speed steel bits to carbon-steel shanks for the purpose of making the high-speed supply go farther.

Other expedients have been resorted to and changes in practice made in a spirit of what might be termed "sour grapes." As a result some shops are learning a lesson that has been too long overlooked. This lesson is that the speed of many cutting operations can be greatly increased over the ordinary when using regular carbon-steel tools. All that is needed is a little study of the conditions.

This possibility is particularly true of multi-toothed cutters, as mills, counterbores and the like. It does not apply with equal force to drills or single-pointed cutting tools for the lathe, planer and shaper.

Factors that should be studied in order to bring about improvements in output with carbon-steel tools are the type of tool used, its general design, the cutting angles, method of support in the machine, and provision for supplying a generous amount of coolant not only to reduce the temperature of the cutting edges, but to remove chips and thus avoid abrasion with its accompanying heating effect.

It is undoubtedly true that one influence of the introduction of high-speed steel was to check the development of carbon-steel tools. We may reasonably assume that the application of the latter is pretty much where it was some ten years ago, or at the time when high-speed steel began to be generally adopted. A long road of experiment and improvement has been traveled in the newer steels themselves, in both composition, production and application. If the same intense study and effort had been spent on carbon steels for tools and in the design and application of the latter, it is fair to assume that the present-day difference in production between the two kinds would be less than it now is. So under the stress of necessity we may turn once more to our old friends—the carbon-steel tools—and see if their productive capacity cannot be increased.

The possibilities of success seem greater when we consider that the special qualities of high-speed steel are not necessary on some kinds of jobs. For many light cuts, where the amount of metal removed and the heating effect are small, carbon steel is probably just as good as its great competitor. It is well not to forget that for a number of years after the introduction of high-speed steel its place was considered to be on heavy roughing cuts on lathe and planer, and for drills.

These comments do not in any way disparage the remarkable achievements that have come from the development and introduction of high-speed steels. They have brought about in machine-shop practice a revolution that is now history. But these alloyed steels in themselves are not a solution of any problem of cutting metal. Other conditions must be studied as well, and many times when this is done in the hope of the possible use of carbon steel the final results are happy, if not equal in degree to those following from the use of the other.

If you cannot get as much high-speed steel as you need, why not find out for yourself the production capacity of your old friend, carbon steel?

Industrial Preparedness

The first definite plan for the industrial preparedness of the United States for war has just been advanced by Secretary Daniels, following the announcement that President Wilson had taken steps to increase the number of civilian engineers actively engaged in studying this national problem. The President addressed an identical letter to the five engineering societies that previously nominated members to make up the Naval Advisory Board. His request was for the selection of one member from each society for each state of the Union. The five men from each state are to form a local committee charged, under Secretary Daniels' plan, with the work of mobilizing the industries of their state. President Wilson's letter to the American Society of Mechanical Engineers reads:

> The work which the American Society of Mechanical Engineers has done, through its members on the Naval Consulting Board, is a public service which is deeply appreciated. It has been so valuable that I am tempted to ask that you will request the society to enlarge its usefulness to the Government still further by nominating, for the approval of the Secretary of the Navy, a representative from its membership for each state in the Union, to act in conjunction with representatives from the American Institute of Mining Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers and the American Chemical Society, for the purpose of assisting the Naval Consulting Board in the work of collecting data for use in organizing the manufacturing resources of the country for the public service in case of emergency.
>
> I am sure that I may count upon your cordial coöperation.

This invitation and the former one that brought about the creation of the present Naval Advisory Board are two of the greatest recognitions of the value of engineering in public life that have ever come to the American engineering fraternity.

Secretary Daniels' plan, in brief, is to collect information with regard to the industrial plants of every state, showing just what each one could do to produce food, clothing, ordnance, munitions or other army supplies. The work of gathering this information and tabulating it for reference and use will be in the hands of the state committees.

It is expected that the Government appropriations for military supplies will be spent through a large number of small contracts placed with manufacturing firms. It is thought that many machine shops will be willing to undertake this work as a semi-patriotic duty, although it is not expected that any shop will lose money in carrying out its contracts. The main thought is to develop a large number of centers, or nuclei, of experience and skill in the manufacture of war material.

For instance, a shop may be given an order for one thousand 3-in. shells with the expectation of repeating this order each year as long as the present policy remains in force. This practice would permit the shop to procure gages, special tools, and stock, and actually to manufacture these shells to meet the Government inspectors' requirements. From the accumulated experience and skill it would be easy to branch out through the shop organization until the entire plant was engaged on munition manufacture in case of a national emergency.

The scheme seems feasible, and if the details are carefully worked out and put into operation with good judgment there seems to be no reason why it should be unsuccessful. However, different industries will have to be handled in various ways. It may be that four classifications will serve: The first would include those where the supplies manufactured for army purposes are identical with whatever is made for general consumption in time of peace. The second might include those where the changes from regular product to army product would be no more than the changes regularly brought about by seasonal demands. The third might include those where the manufacture of war material presents entirely new problems and must be attacked in a different manner from the methods used for regular products. The fourth and smallest class might include industries whose products under no conditions can be manufactured successfully in small quantities, but require a highly specialized equipment and large orders to produce at all.

Without attempting to list the various industries which fall under each class, a few examples in each case will clarify our thinking.

The first class would naturally include the production and manufacture of all kinds of food, hospital supplies, and transportation. A soldier can enjoy the same kind of canned corned beef in the trenches that his wife serves on the home table. He can be transported in the same make of automobile that he used in his native town, or on the same kind of motor truck that was owned by his home shop; and the medical supplies that contributed to his welfare in time of peace can aid him equally well in war.

A good example of product in the second class is shoes. It is evident that it would be no more difficult to change over a shop manufacturing a regular line of men's shoes to make army shoes than to change from summer to winter styles. In like manner, looms used for weaving duck could be changed over for tent cloth or khaki; and hosiery and underwear mills, with slight modifications in material and designs, could go onto army work. In this class would also be all the machine-tool and small-tool industries.

The third class represents a different problem and includes the manufacture of ordnance, ammunition and practically all army supplies made of metals. A shop producing sewing machines can be changed over to make fuses, but the experience of the last eighteen months shows how long a time it takes to do it and make it a success. In a similar way a plant making electrical machinery or steam turbines can turn to shells, and a shop or plant ordinarily engaged on general machine work can make field guns; but these changes take time. They mean the development of a completely new set of methods, small tools, gages, fixtures, cutting tools, etc.

The number of items which enter into the fourth class is much smaller than in any of the others. The most important is the industry of manufacturing rifles and machine guns and their ammunition. Developing a shop organization, collecting the machines and producing the special tools for making a rifle constitute a stupendous task. It has been said that it takes three years to develop a good rifle-barrel driller. It is not feasible to imagine that we can farm out a thousand rifles here and another thousand there and have them produced on the same basis that will prove successful for a thousand shells. Unquestionably the manufacture of rifles, machine guns and a few similar highly organized machine-shop products must be done in large, concentrated plants, especially equipped to do the work and having a sufficient volume of consecutive orders so that they can be operated at practically full capacity year in and year out.

It is evident that the manufacturing methods for classes 1, 2 and 4 can be the very best that we know. In regard to class 3, it is not so possible. If a shop receives a comparatively small order each year, it cannot afford to develop the methods to such a high pitch as if an enormous volume is required. From one viewpoint this is no serious objection, however, for in case of national emergency the general machine-shop equipment of this country would have to produce the greater part of the shells and ordnance that would be required. Thus if the average shop uses its regular equipment and develops methods in keeping with good general machine-shop practice, it is possible that all that can be reasonably expected would be done. At the same time the tools and gages should be planned as closely as possible in keeping with the most highly developed methods and processes used anywhere. For this reason, somewhere in the great Middle West, possibly in southern Illinois, there should be established a huge American arsenal to become the center, the very heart, of the manufacture of munitions in the United States. Here constant experiment and study should be made, both to standardize and develop the types of munitions and to improve the manufacturing processes. This plant should be the example, the great school, the training place for all the other shops of the country. From this center should radiate the lines of influence which would tend to introduce the best possible methods into every one of the nucleus shops.

In spite of the apparent difficulties, the proposed plan possesses many points of practicability, and the *American Machinist* is glad to indorse it heartily in principle. It differs from many of the schemes that have been branded with the word "adequate" in that no large sums of government money are asked for or necessary to put it into effect. This is very much in its favor. A parallel has been drawn between the present and the period just before the Revolutionary War. The colonies prepared for a possible emergency. The "Minute Man" came into being. We are now asked to prepare against possible emergency. The plan is now to train "Minute" shops.

Shop Equipment News

Plain Bench Miller

In the illustrated description of the plain bench miller appearing on page 169, the name of the manufacturer—Miller & Crowningshield, Greenfield, Mass.—was inadvertently omitted.

Heavy-Duty Boring Lathe

In the illustration is shown a heavy-duty boring lathe recently developed by the Giddings & Lewis Mfg. Co., Fond du Lac, Wis.

The boring bar has a single cutting tool, and the boring bar, with its housing, moves across the bed by means of a forming attachment at the rear, which causes the bar to travel exactly to conform to a master contour.

A lever movement throws in the clutch attached to a traverse screw running down through the bed lengthwise. The traverse screw passes through a nut attached to the carriage. The traverse screw starts the carriage to the right and when it has arrived at the end of the bed, a rod, on which are mounted adjustable nuts, comes in contact with a lever throwing out the clutch and stopping the carriage. In this position the forging can be removed from the chuck and another inserted. A lever movement to the right then throws in a reverse clutch on the traverse screw which brings the carriage to within a short distance of the stop attached to the lathe bed, when the adjustable nut on the rod throws the lever to the left, stopping any further movement of the carriage. To avoid the stop being thrown out of position, by the force of the carriage striking it at the instant the clutch is disengaged, nuts are adjusted on the rod so as to throw out the clutch before the carriage strikes the stop.

A crank handle is attached to a shaft that runs through the bed, engaging a pair of miter gears. One miter gear is splined to the traverse screw; therefore, by rotating the crank it slowly brings the carriage up against the stop, in which position the carriage is clamped to the bed by tightening up the hold-down nuts. Another lever movement to the left starts the bar by starting a train of gears and then pushing another lever over toward the boring bar, sliding the gear in mesh. The bar then starts forward and continues in a straight line until it arrives at the point to begin the contour of the forging.

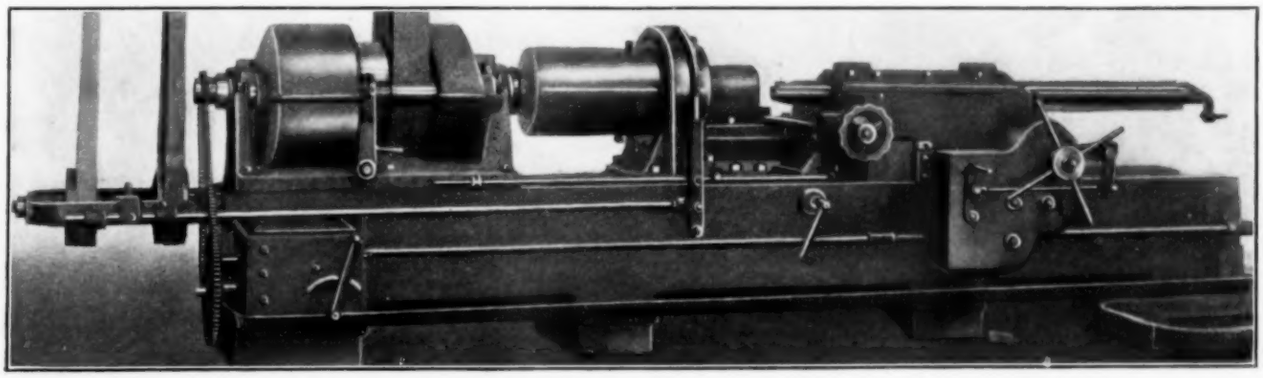
The shaft just above the pilot wheel has a pinion engaging the rack on the boring bar, and also a pinion exactly the same size engaging the rack for moving the forming slide. Either end of this rack is turned down and has two adjusting nuts. To the slide is attached the radius link with 30-in. centers.

It will be realized that by adjusting the nuts on the rack, the instant the tool has arrived at the point to begin the contour the nuts press against the end of the slide, carrying it forward toward the left, drawing the boring bar with it to make a radius of exactly 30 in.

The boring-bar head is gibbed to the forward slide on the carriage. When the boring bar has traversed to a predetermined distance, or the end of the cut, an adjusting screw presses against a lever on the rockshaft, which movement brings another lever over to the right, throwing out the jaw clutch on the bevel feed pinion and stopping any further movement of the bar. In this position the operator can either pull the lever forward, disengaging the feed pinion, permitting him to rotate the pilot wheel and withdraw the bar, or preferably loosen up the hold-down nuts on the carriage, throwing a lever forward, traversing the carriage to the right. This movement of the carriage to the right will, when the nuts on the sliding rack hit the slide, bring the link to exactly right angle of the boring bar.

The machine shown is also built without the former at the back, and making the boring bar fixed. The machine may also be obtained with any gear reduction from 7½ to 1 to 15 to 1 or more. In place of the two-step cone a single pulley for 10- or 12-in. belt can be substituted.

The machine shown is arranged with double back gear and two-step cone receiving power from a 6-in. belt. The back-gear ratios are 7½ to 1 and 5 to 1. The main driving gears are 3-pitch and 3½-in. face. Other driving gears are 4-pitch and 2½-in. face. The carriage or bor-



HEAVY-DUTY SINGLE-PURPOSE BORING LATHE, WITH FORMING ATTACHMENT AT REAR

Swing over bed, 15 in.; hole through spindle, 1⅛ in.; front bearing, 5½x10 in.; back bearing, 4½x7 in.; length of carriage bearing on bed, 46 in.; pulleys on countershaft, 20x6¾ in., tight and loose; speed of countershaft, 130 r.p.m.; size of boring bar, 4½ in. by 7 ft.

ing-bar head has a bearing on the bed of 46 in. and has quick traverse. The movement of boring bar is by geared feeds, and the rate of feed in thousandths of an inch per revolution of spindle is: 0.020, 0.027, 0.037, 0.048, 0.068, 0.093, 0.123 and 0.163, all obtained by quick-change gear box. The bar is made from crucible hammered steel 4½ in. diameter. It has quick return and adjustable automatic limit stops in both directions, and has No. 7 Morse taper hole. The machine weighs about 16,000 lb.

Self-Centering Shell Chuck

The Jenckes Knitting Machine Co., Pawtucket, R. I., has recently developed a self-centering chuck for holding shells while they are machined.

A view of the assembled chuck is shown in Fig. 1. It is made with a machine-steel body and was designed

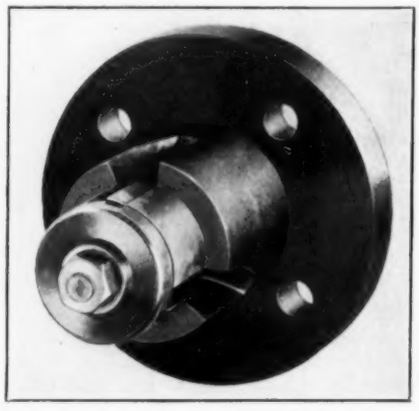


FIG. 1. THE ASSEMBLED CHUCK

for the 3-in. shell. In Fig. 2 are shown details of the chuck. The tool is made with a flange that is attached to the faceplate by four bolts, or screws. The driving action is obtained by three hardened-steel dogs that are kept

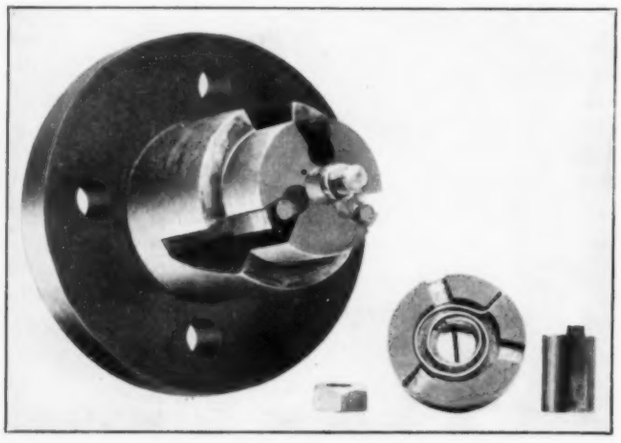


FIG. 2. DETAILS OF THE CHUCK

in tension with a spring in the cap, which is held in position with a nut.

In using the chuck the shell is slid over the shank, and the tool comes in contact with the shell to machine it. The chuck is revolved with the lathe and forces out the driving dogs. Their edges come in contact with the inside of the shell and drive it.

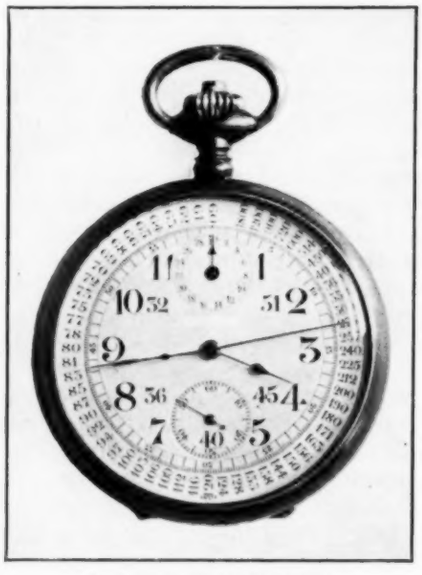
It will be observed that, as the dogs operate in unison, the chuck is self-centering. Another advantage is that the driving effect of the chuck is increased as added demand is made on the action of the dogs.

Master Cronograph

The instrument shown is designed to be useful in making time and motion studies and in obtaining direct results of production per hour or per day, both for mechanical and manual operations.

The cronograph contains a 17-jewel timepiece and divisions in seconds and fifths for the time-study feature. The figures on the extreme outside of the dial designate operations per hour for any operation within one minute, and the figures on the extreme inside of the dial, such as 51, 45, 40, etc., denote operations per hour for any operation running into the second minute. For instance, if the large black hand were stopped on 13 sec., which would denote the completion of an operation, the reading directly under this hand would show 275, the number of operations which could be completed in one hour on a basis of one operation taking 13 sec.

The instrument operates entirely from the crown, being the start, stop and fly-back system. The timepiece



MASTER CRONOGRAPH

feature is the same as any modern watch. The works are impervious to magnetism, to heat and cold, expansion and contraction. The case is of gun-metal. The product is of Swiss manufacture, and the sales rights are controlled by M. J. Silberberg & Associates, Peoples Gas Building, Chicago, Ill.

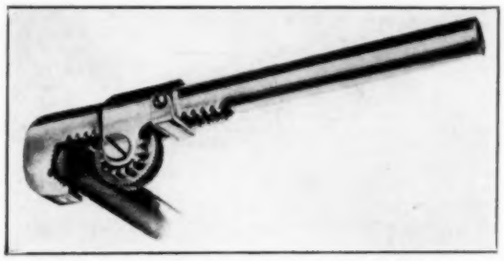
Self-Adjusting Pipe Wrench

The automatic pipe wrench shown derives its automatic feature from a combination of a rotating disk, constituting the under jaw, and a spring hung in the hollow handle. This spring constantly keeps the under jaw pushed forward, thus holding the tool in continuous contact with any size of pipe within the capacity of the various sizes of the wrench.

The head, or upper jaw, is a drop forging made from high-carbon steel and is V-shaped, thus rendering a two-

point contact. The handle is made from flat cold-rolled steel. It is formed, stenciled and milled. The head and handle are joined by a brazed joint having a large bearing. The saddle and saddle cap are blanked from cold-rolled steel and formed.

The disk, or under-jaw, which is really the most vital part of the tool, consists of pinions on each side. This



SELF-ADJUSTING PIPE WRENCH

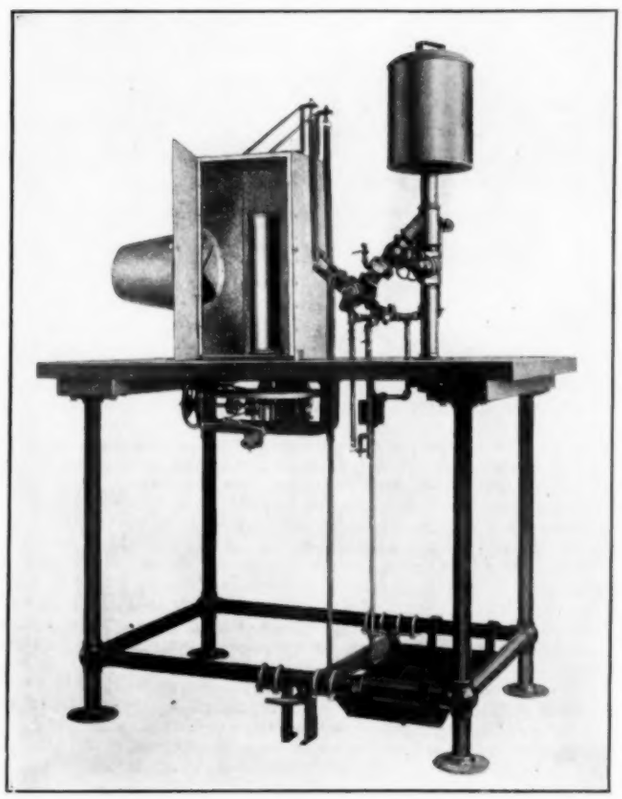
part is made from a special grade of bar steel. The blank for it is central-drilled and cut from the bar, then heated to a high forging temperature and the pinions formed by a special die operation.

The wrench is a recent product of the Craftsman Tool Co., Conneaut, Ohio.

Shell Coating Machine

The shell-painting machine shown, designed for outside coating, is the latest addition to the line made by the Spray Engineering Co., Boston, Mass.

The machine consists of a table with steel supporting frame, the operating mechanism being mounted beneath the table top. The usual coating material, such as varnish, asphaltum, paint and similar special compounds, is carried in a reservoir supported above the operating table. The liquid coating material passes down the hollow reservoir support to an adjustable measuring device controlling the amount of material sprayed at each operation. A system of levers controls the motion of the device that cuts off the supply from the reservoir and admits the measured quantity of material to a channel leading to the spray nozzle. The last part of this motion admits a compressed-air supply that drives the coating material through the spray nozzle and distributes it evenly over the surface to be coated.



SHELL SPRAYING MACHINE

Drain and priming valves are provided to permit the thorough cleaning of the measuring device and all pipes and passages without taking the mechanism apart.

The machine shown is equipped with a motor-driven rotating shell table and also with an exhaust fan mounted in a sheet-metal hood for protecting the operator from the paint fumes.

Electric Shop Trucks

The storage-battery shop trucks shown represent recent additions to the line made by the Buda Co., Chicago, Ill.

The trucks are worm driven, the transmission mechanism forming a simple unit, of which all wearing parts continually operate in a bath of lubricating oil. The brake and circuit-breaker are operated by a foot pedal, consisting of one-half of the operator's platform. In using the trucks the operator needs only to depress the

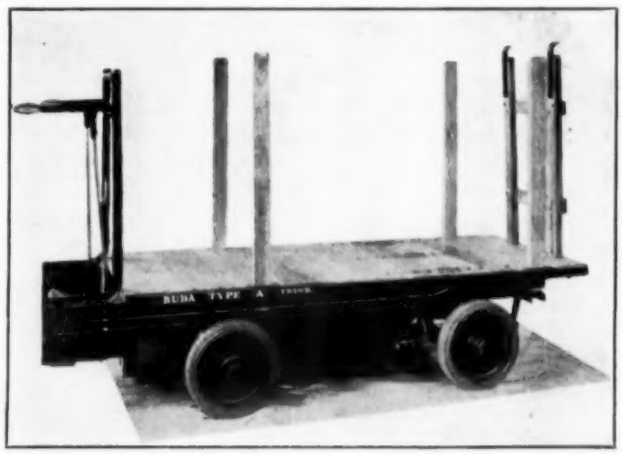


FIG. 1. STORAGE-BATTERY WAREHOUSE TRUCK
Length, 8 ft.; width, 40 in.; capacity, 4,000 lb.; 3 speeds

FIG. 2. HANDY TYPE OF ELECTRIC TRUCK
Length, 8 ft.; width, 40 in.; capacity, 4,000 lb.; 3 speeds

foot pedal, thus completng the circuit and also releasing the brake. Should the operator remove his foot from the foot pedal, it is instantly returned to its normal position by a spring, thus automatically breaking the circuit and also releasing the brake. Likewise the controller lever, which is equipped with a simple set of equalizing springs, is automatically returned at once to its neutral position the instant the operator's hand is taken from it.

The tires are of solid rubber, mounted on metal rims. The wheels have tapered roller bearings. The front axle is a steel casting, and the rear axle is of the full floating type. Both axles are carried on heavy spiral springs within the pedestals; all revolving members are carried on ball bearings and ball thrust bearings. The frames are made of heavy channel iron.

The truck shown in Fig. 1 has a two-wheel steer and is adapted for carrying miscellaneous loads upon its own deck, under which are the batteries. The truck shown in Fig. 2 has a four-wheel steer, with the batteries mounted directly in front of the operator.

The motors used are of the all-enclosed type. The speeds of the trucks are varied by means of a controller lever traveling in a vertical plane, the normal position of which lever is horizontal. In conjunction with this lever there is a simple arrangement for equalizing springs.

Turret Screw Machine

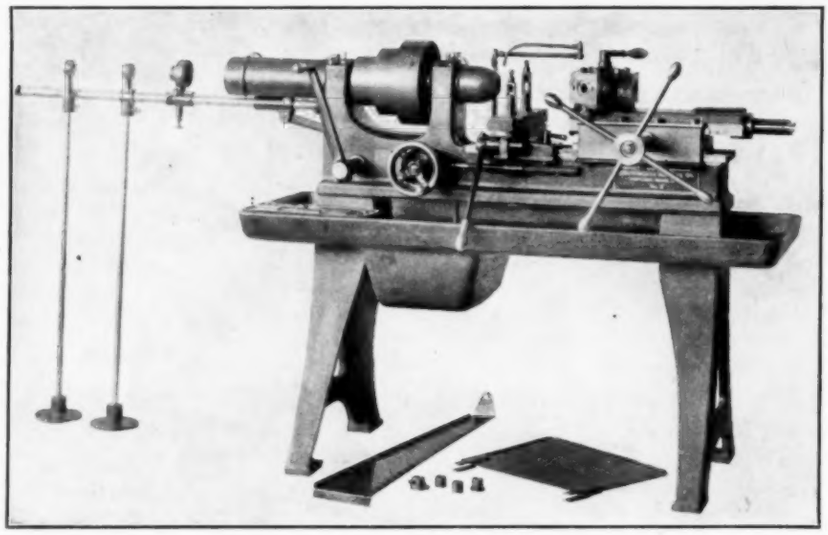
The hand screw machine shown is provided with a plain head, automatic chuck, bar feed and hand longitudinal feed to cutoff.

The head and bed are cast integral. The automatic chuck and bar feed are operated by a long lever in front of the head, giving increased leverage for closing the collet. A stepped thimble automatically adjusts the collet for slightly varying diameters.

The hexagonal turret has six tool holes arranged for holding tools with or without shanks. The holes for shank tools are fitted with binder bushings. Bolt holes are provided for securing tools to the faces, the counterbore being made to receive a boss on the back of the tool, which accurately locates and keeps the tool in alignment. The turret is revolved automatically by the backward movement of the slide. A neutral point is provided so that the turret can be revolved in either direction by hand. The locking bolt is at the front end of the slide, directly under the cutting tool, and works into steel taper bushings placed in the bottom of the turret at nearly its full diameter.

Independent adjustable stops operate automatically for each position of the turret. They are readily adjustable for the length of each cut. The turret saddle has a supplementary taper base, by means of which the tool holes in the turret can be adjusted to the exact height of the center of the spindle. Taper gibs, fitted the whole length of the saddle on each side, provide means of adjusting the slide sidewise.

The cutoff saddle is constructed to maintain the alignment by providing a narrow guide and taper adjusting gib. The cutoff saddle has an increased bearing on the bed, with a binder for clamping. The hand longitudinal feed is operated by means of a handwheel in connection with miter gears and a milled screw and is fitted with a graduated dial reading to 0.001 in. Dial indicators are provided to obviate the necessity of making measurements of the longitudinal cuts.



HAND SCREW MACHINE EQUIPPED WITH AUTOMATIC CHUCK

Automatic chuck capacity, 1 in.; hole in automatic chuck plunger, 1⅛ in.; diameter of turret holes, 1 in.; center of holes to top of slide, 2⅜ in.; diameter across flats, 7⅛ in.; swing over bed, 14 in.; swing over cutoff slide, 6 in.; length that can be turned, 6 in.; greatest distance, end of collet to turret, 15 in.; greatest distance, end of spindle to turret, 16¼ in.; horsepower required, 1½

The cutoff slide is provided with four T-slots. The two in front run parallel with the cutoff slide, permitting close adjustment of the tool posts. A geared oil pump delivers lubricant through an adjustable piping system. It operates automatically.

The machine is a recent product of the Southworth Machine Co., Portland, Me., for whom Manning, Maxwell & Moore, New York City, are selling agents.

NEW PUBLICATIONS

SCIENTIFIC MANAGEMENT AND LABOR—By Robert F. Hoxie. New York: D. Appleton & Co. Cloth; 5½x7¾ in.; pp. 302. $1.50.

Reviewed by Dexter S. Kimball*

Professor Hoxie's book is the first of a type of which no doubt we shall see more in the immediate future. Heretofore the greater part of the discussion concerning scientific management has come from engineers, managers and others actively connected with industry. An evaluation of scientific management by a trained economist who has had a rather unusual opportunity to study these new things at close range is therefore of great interest.

The book is based upon an investigation of scientific management in its relation to labor made by Professor Hoxie for the United States Commission on Industrial Relations and is an attempt to test the claims of the late Frederick W. Taylor respecting scientific management as it refers to labor. The book deals therefore with this phase of the problem only and is not a treatise on the theory and practice of so-called scientific management.

The subject matter is divided into three sections, as follows: Part 1. Viewpoint and Method. Part 2. Critical Examination of Scientific Management in Its Relation to

*Professor of machine design and construction, Sibley College.

Labor. Then came the following appendices: (1) Conclusions Resulting from the Investigation. (2) The Labor Claims of Scientific Management According to Mr. Taylor. (3) The Labor Claims of Scientific Management According to Mr. Gantt. (4) The Labor Claims of Scientific Management According to Mr. Emerson. (5) The Trade Union Objections to Scientific Management. (6) Vital Points at Issue Between Scientific Management and Labor Based Upon the Claims of Scientific Management. (7) Vital Points at Issue Between Scientific Management and Labor Based Upon Trade Union Objection to Scientific Management. (8) Questionnaire: Scientific Management and Labor.

In taking up the investigation Mr. Hoxie first made a study of scientific management as presented by its leading advocates. All the important literature bearing on both sides of the question was examined, and representatives on both sides of the controversy were consulted. With these data as a basis, two preliminary statements, entitled respectively "The Labor Claims of Scientific Management" and "Trade Union Objections to Scientific Management," were prepared. The first of these documents was submitted to prominent scientific managers for criticism and revision, while the second was revised and approved by a committee of the American Federation of Labor. From these official statements the vital questions at issue were determined, and they are set forth in appendices 6 and 7. The Questionnaire, appendix 8, was compiled from these documents and used as a means of securing extended information from both employers and employees. The investigating committee also visited a large number of shops where scientific management has been installed in whole or in part and also consulted many individuals concerning the problem. It will be seen therefore that the appendices are important documents, for aside from any conclusions that have been drawn by Mr. Hoxie, appendices 6 and 7 show in a clear and concise form the points at issue, while appendix 8, which is quite voluminous, gives one an idea of the complexity and extent of the controversy.

The conclusions of Mr. Hoxie and his committee, however, are of greater importance. It may be well to quote directly from the report itself, which states:

> Two essential points stand forth. The first point is that scientific management, at its best and adequately applied, exemplifies one of the advanced stages of the industrial revolution which began with the invention and introduction of machinery. Because of its youth and the necessary application of its principles to a competitive state of industry, it is, in many respects, crude, many of its devices are contradictory of its announced principles, and it is inadequately scientific. Nevertheless, it is to date the latest word in the sheer mechanics of production and inherently in line with the march of events.
>
> The second point is that neither organized nor unorganized labor finds in scientific management any adequate protection to its standards of living, any progressive means for industrial education, or any opportunity for industrial democracy by which labor may create for itself a progressively efficient share in efficient management. And, therefore, as unorganized labor is totally unequipped to work for these human rights, it becomes doubly the duty of organized labor to work unceasingly and unswervingly for them, and, if necessary, to combat an industrial development which not only does not contain conditions favorable to their growth, but, in many respects, is hostile soil.

Mr. Hoxie's findings verify what the reviewer has long contended[1], namely, that scientific management at its very best is essentially a means of increasing productive capacity and does not carry with it a single regulative principle that automatically tends to protect the individual worker against certain results that ensue from its introduction exactly like those that follow the introduction of labor-saving machinery. In common with all methods looking to results in productive effort these methods make possible better conditions for the race as a whole. But experience with labor-saving machinery has made it clear that the distribution of the benefits flowing from improved methods cannot be left to chance, since these methods themselves afford no protection to the worker during the period of readjustment following the introduction of more economic methods.

The need of taking advantage of every economic gain is undoubted, and the human race in general never discards any ways or means to that end. The great problem therefore is to develop these methods while at the same time safeguarding human rights, and the reviewer agrees with Mr. Hoxie that this effort cannot be safely left to scientific management, which depends on personal good will to correct abuses that may result because of its introduction.

Mr. Hoxie frankly questions the claims made by exponents of scientific management that time study can be scientifically accurate and states that "far from being the invariable and purely objective matter that they are pictured the methods and results of time and task study in practice are subject to all the possibilities of diversity, inaccuracy and injustice that arise from human ignorance and prejudice." While this statement will be flatly contradicted by some and will be considered overstrong at least by many more, there is no doubt that there is considerable truth in Mr. Hoxie's statement. Time study is not and cannot be an exact science.

Mr. Hoxie makes a similar criticism of the basis of advanced wage systems. Granting that it is possible to measure accurately the task a worker ought to perform, the claim that these advanced wage systems reward the worker in proportion to his effort is, as he points out, begging the question so long as these systems use the rates already determined by competition as a basis for efficiency reward, since these very basic rates are in dispute.

The most interesting and in many respects the most important section of the book is Part 2, which discusses scientific management as the investigator found it to exist in actual practice. This discussion, on the whole, is not over-favorable to scientific management, and one is likely to gain the idea that the author is biased in his opinion.

It should be noted, however, that Mr. Hoxie concedes fully the economic possibilities of the new methods, his criticisms being directed more against false claims and the mistakes and possible injustices arising from the use of these methods in the hands of ignorant practitioners. On the latter he is severe, and justly so.

It may be objected and perhaps with some justice that the report and discussion are based upon collected opinions rather than upon intimate personal knowledge. On the other hand, it should be remembered that Mr. Hoxie was assisted in this investigation by a representative of labor and a representative of employing management, both of whom signed the report.

Whether one agrees or not with all of Mr. Hoxie's conclusions, all who have examined this difficult problem with an unbiased mind will certainly agree with him that we need more thorough study and general publicity concerning the true character and methods of scientific management and concerning the real character, intelligence and spirit of those engaged in its application.

[1] See "American Machinist," Vol. 35, page 263.

PERSONALS

James C. Kelly, for many years with Berry Bros., joined the selling staff of the Moller & Schumann Co., Brooklyn, N. Y.

Frank J. Shay, until recently New England representative of Berry Bros., is now a member of the selling force of the Moller & Schumann Co., Brooklyn, N. Y., operating from headquarters in Boston.

Charles W. Burrage, formerly of the faculty of the Massachusetts Institute of Technology, and associated with the F. W. Dodge Co., has joined the organization of Walter B. Snow and staff, Boston, Mass.

Joseph A. Holland, for many years secretary of the Rhode Island branch of the National Metal Trades Association, has resigned to become supervisor of employment with the General Electric Co., Schenectady, N. Y.

OBITUARY

John Butterworth, one of the proprietors of the New Jersey Agricultural Works, Trenton, N. J., and for many years well known in the farm-implement field, died at his home in that city on Jan. 21. Mr. Butterworth was born in Pawtucket, R. I., in 1833.

Robert Howard Grant, for many years conspicuous in the ball-bearing development in this country, and widely known as a designer of ball-making machinery, died at his home in Ann Arbor, Mich., Jan. 11, after a long illness. Mr. Grant was born in Northampton, Mass., in 1867. After completing a high-school education in Fitchburg, Mass., he entered the shops of Simonds Rolling Machine Co., of that city. Shortly thereafter he became assistant superintendent of the Jones & Lamson Machine Co., which he left in 1888 to become associated with the Cleveland Automatic Machine Screw Co., of which his father, John J. Grant, was then the leading spirit. Later Robert withdrew from his father's concern to start the Grant Auto-Friction Ball Co., Cleveland, Ohio. From then on, until very recent times, Mr. Grant was in turn associated with most of the leading ball-producing plants in this country, founding the Grant-Hoover Ball Co., and the firm of Grant & Wood, Chelsea, Mich. A few years ago Mr. Grant organized the Grant Tool Co., Detroit, Mich., which was later merged into the Detroit Tool Co. He is survived by his wife and two sons.

Prices--Materials and Supplies

Pig Iron—Quotations were current as follows at the points and dates indicated:

	Jan. 28, 1916	Dec. 30, 1915	Jan. 29, 1915
No. 2 Southern foundry, Birmingham	$15.00	$14.50	$9.50
No. 2 X Northern foundry, New York	19.75	19.50	14.25
No. 2 Northern foundry, Chicago	18.50	18.50	13.00
Bessemer, Pittsburgh	21.45	20.45	14.55
Basic, Pittsburgh	18.70	18.95	13.45
No. 2 X, Philadelphia	20.00	19.50	14.25
No. 2, Valley	18.50	18.50	13.00
No. 2 Southern, Cincinnati	17.90	17.40	12.40
Basic, Eastern Pennsylvania	19.50	18.50	13.50
Gray forge, Pittsburgh	18.45	18.20	13.45

Steel Shapes—The following prices in cents per pound are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger from jobbers' warehouse, New York:

	Jan. 28, 1916	Dec. 30, 1915	Jan. 29, 1915
Steel angles, base	2.60	2.40	1.85
Steel T's, base	2.65	2.45	1.90
Machinery steel (bessemer)	2.60	2.40	1.80

Steel Sheets—The following are the prices in cents per pound from jobbers' warehouse, New York:

	Jan. 28, 1916	Dec. 30, 1915	Jan. 29, 1915
No. 28 black	3.50	3.15	2.60
No. 26 black	3.40	3.05	2.50
Nos. 22 and 24 black	3.35	3.00	2.45
Nos. 18 and 20 black	3.30	2.95	2.40
No. 16 black	3.45	2.90	2.35
No. 14 black	3.35	2.80	2.25
No. 12 black	3.30	2.70	2.20
No. 28 galvanized	5.50	5.50	3.50
No. 26 galvanized	5.20	5.20	3.20
No. 24 galvanized	5.05	5.05	3.05

Bar Iron—Prices are as follows in cents per pound at the places named:

Pittsburgh, mill	2.10
New York	2.20@2.25
From storehouse, New York	2.50@2.60

Swedish (Norway) Iron—This material sells at $4.50 base per 100 lb. f.o.b. New York. In coils an advance of 50c. is charged.

Cold Drawn Steel Shafting—From New York warehouse to consumers requiring fair-sized lots the price is 20% off list.

Standard Pipe—On carload lots f.o.b. Pittsburgh, the discounts follow:

	Black		Galvanized	
	Jan. 21, 1916	Jan. 22, 1915	Jan. 21, 1916	Jan. 22, 1915
¾- to 2-in. steel butt welded	76%	81%	60½%	72½%
2½- to 6-in. steel lap welded	75%	80%	59½%	72½%

At these discounts, the net prices in cents per ft. follow:

Diameter, In.				
¾	2.76	2.20	4.54	3.15
1	4.08	3.24	6.72	4.67
1¼	5.44	4.38	9.09	6.30
1½	6.60	5.25	10.86	7.55
2	8.88	7.05	14.62	10.15
2¼	14.63	11.70	23.69	16.70
3	19.13	15.25	30.98	21.80
4	27.25	21.80	44.05	31.00
5	37.00	29.60	59.94	42.20
6	48.00	38.40	77.76	54.60

Seamless Drawn Tubing—The base price per pound from New York warehouse is 38c. for brass and 38.50c. for copper. For immediate stock shipment 3c. is added, which gives the following quotations:

	Copper		Brass	
Diameter, In.	Jan. 28, 1916	Jan. 29, 1915	Jan. 28, 1916	Jan. 29, 1915
¾ to 2½	41.50	21.50	17.00	41.00
3	41.50	22.00	18.00	41.00
3½	42.50	22.50	18.50	42.50
4	43.50	23.00	19.00	43.50
4½	45.50	24.00	20.00	45.50
5	47.50	25.00	21.00	47.50
6	48.50	28.00	24.00	48.50
8	52.60	32.00	28.00	52.60
7	50.50	30.00	26.00	50.50

Wire Rope—On this material the following discounts are for warehouse delivery, New York:

Galvanized	35 and 2½%
Bright	45 and 2½%
Special brands, bright	40 and 2½%

Miscellaneous Metals—The present New York quotations in cents per pound, with a comparison of practically a month and year ago, are as follows:

	Jan. 28, 1916	Dec. 30, 1915	Jan. 29, 1915
Copper, electrolytic (carload lots)	25.50	22.50	14.50
Tin	41.75	40.00	35.75
Lead	6.10	5.40	3.70
Spelter	19.50	18.00	8.25
Copper sheets, base	31.00	27.00	19.00
Copper wire (carload lots)	31.00	30.25	15.00
Brass rods, base	37.00	32.00	14.50
Brass pipe, base	42.00	36.00	15.50
Brass sheets	37.00	32.00	14.75
Solder ½ and ½ (case lots)	26.12½	24.75	22.50

In St. Louis lead sells at 5.95 and spelter for delivery in February or March at 19.50 For delivery May or June, the quotation is 16.50.

Old Metals—In New York, the following are the dealers' purchasing prices in cents per pound:

	Jan. 28, 1916	Dec. 30, 1915
Copper, heavy and crucible	20.00	17.75
Copper, heavy and wire	19.50	17.25
Copper, light and bottoms	17.00	15.00
Lead, heavy	5.00	4.50
Lead, tea	4.50	4.25
Brass, heavy	12.75	11.50
Brass, light	10.00	9.50
No. 1 yellow rod brass turnings	12.50	14.00
No. 1 red brass or composition turnings	12.00	11.50
Zinc	12.00	11.00

Babbitt Metal—In New York, quotations are as follows in cents per pound:

Best grade	55@60
Commercial grade	25@30

Antimony—For Chinese and Japanese brands the quotation is nominal at 42.50c. per lb., duty paid.

Monel Metal—The following are the prices in cents per pound for mill lengths 8 ft. and over:

Size, In.	10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less Than 500 Lb. of a Size and Over
Rounds—Squares					
⅜ to ⅞	31.50	32.00	32.50	33.00	36.00
¼ to 1⅛	31.25	31.75	32.25	32.75	35.75
⅜ to 1⅞	31.00	31.50	32.00	32.50	35.50
1⅛ to 2⅞	31.75	32.25	32.75	33.25	36.25
Rounds					
3 to 3 7/16	32.50	33.00	33.50	36.00	37.00
Squares					
3	32.50	33.00	33.50	36.00	37.00
Rounds					
3½ to 3 13/16	32.25	32.75	33.25	35.75	36.75
Squares					
3 7/16 to 3 13/16	32.25	32.75	33.25	35.75	36.75
Rounds—Squares					
4 to 4 13/16	33.00	33.50	36.00	36.50	37.50
5 to 6 13/16	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ⅛ in. thick.

Hexagon bars 2c. per lb. over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

Tin Plates—The following prices are in effect from warehouse, New York:

Coke tin plate, 14x20:

100-lb.	$4.45
I. C. 107-lb.	4.60

Terne plate, 20x28:

Base Weight	Net Weight	Coating	Price	Base Weight	Net Weight	Coating	Price
100-lb.	200	8	$8.30	I. C.	226	20	$13.50
I. C.	214	8	8.60	I. C.	231	25	14.25
I. X.	270	8	10.60	I. C.	236	30	15.50
I. C.	218	12	12.00	I. C.	241	35	17.00
I. C.	221	15	13.00	I. C.	246	40	19.00

Coke—The following are prices per net ton at ovens, Connellsville, and cover the past four weeks:

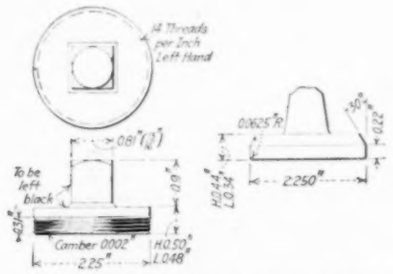
	Jan. 8	Jan. 15	Jan. 22	Jan. 29
Prompt furnace	$3.25@3.50	$2.50	$3.00@3.25	$4.00@5.00
Prompt foundry	3.50	3.75@4.00	3.50@4.00	3.50@4.00

Manufacturing British 18-Pounder High-Explosive Shells--IV*

By E. A. Suverkrop

SYNOPSIS—The body of the high-explosive shell is merely a container for a quantity of high explosive that, as a matter of prime importance, must be protected from premature detonation. In all steel bars there is a possibility of piping. Should a pipe be present in the base of a high-explosive shell and should no precautions be taken to seal it, the flame from the propulsive charge in the gun might communicate with the explosive charge in the shell, resulting in wrecking the gun and killing or maiming all the men in the vicinity.

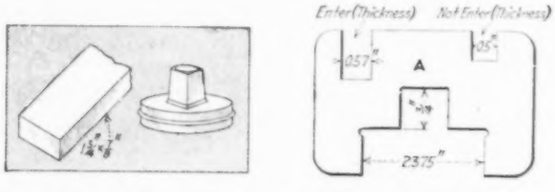
The bases of all high-explosive shells are sealed with steel base plates. In order to make the sealing more positive the base plates are made from flat steel bars worked



FIGS. 38 AND 39. TWO TYPES OF BASE PLATES

Fig. 38—Threaded base plate for 18-pounder high-explosive shell. Fig. 39—Plain riveted base plate

so that the grain of the metal in the finished base plate, when it is in place in the shell, runs at right angles to the grain of the metal in the shell itself. With the base plate made in this manner, even should there be pipes in both the base plate and the shell, they will run at right angles to each other and in different planes when the shell and plate are assembled. There will consequently be no pos-



OPERATION 23. DROP-FORGING BASE PLATES

Machines Used—Billings & Spencer and Bliss drop hammers.
Special Fixtures and Tools—Oil furnaces, trimming press and dies.
Gages—Diameter and thickness gages A and B.
Production—One man, one furnace and one hammer, 110 pieces per hour.
References—See Figs. 38, 39, 40, 41 and 42.

sibility of connection between them and therefore no means of communication between the propulsive and explosive charges.

As previously stated, two types of base plates are now permitted by the Government authorities—one, threaded as shown in Fig. 38; and the other, a riveted base plate shown in Fig. 39, which is now used at the Dominion Bridge Works. The blanks for both types are made under Billings & Spencer and Bliss drop hammers in the drop-forge shop, shown in Fig. 10.

In Fig. 41 is shown the drop-forging die for both types of base plates. In Fig. 42 is shown the die for the larger base plate used in the 4.5-in. shells. It will be noticed that the large base-plate forging is of the shape required for threading. Experiments have been made with plain riveted base plates for the larger sizes of shells, but so far no particular type of riveted base plate for the larger sizes of shells has been adopted as a standard.

The steel used for these dies—one that has given entire satisfaction—is Jessop's, containing 0.75 per cent. carbon. With the equipment found in the average toolroom a die like this should be made in about 75 hours. This time could probably be cut considerably by a drop-forge-die maker. When finished, the dies are heated to about 1,450 deg. F. and quenched in water. Before they are quite cold, they are removed from the water and immersed in fish oil, where they are allowed to cool off gradually. It is well to remember that the exact quench-

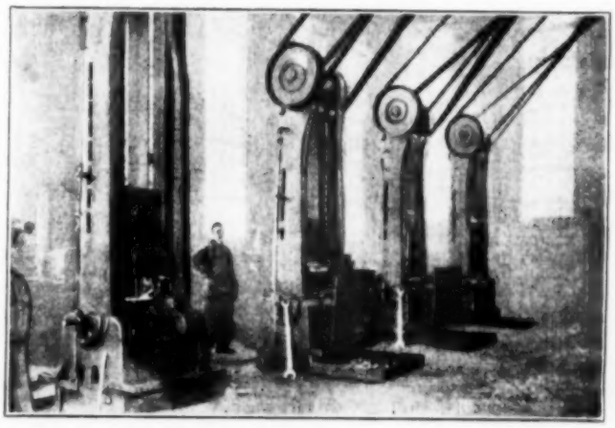


FIG. 10. DROP HAMMERS IN THE FORGE SHOP

ing temperature depends on the size and shape of the piece, as well as on the carbon content.

The average life of the dies on this work is about 20,000 forgings for the small dies and 18,000 for the large size before the impression wears so that resinking becomes necessary.

The steel used for forging the base plates is 0.50 carbon, but satisfactory tests have been made with 0.20 carbon steel for this purpose, although none of this is used. For the small plates the stock used is $1\frac{3}{4}$x$\frac{7}{8}$ in., and for the large plates $2\frac{1}{2}$x$\frac{7}{8}$ in.

The drop-hammer operator can on an average make 110 small plates an hour, or 85 large ones. The trimming die is an ordinary round die with a punch to match. An operator can trim about 550 of either size of forgings per hour. While not actually an operation on the shell itself, this making of the base plate will be considered as the twenty-third operation in this series.

*Previous installments appeared on pages 1, 45 and 145.

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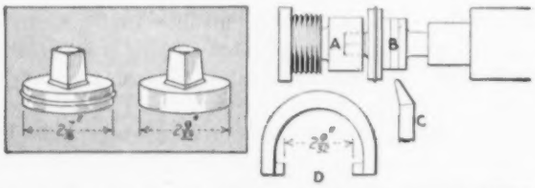
After forging, the base plates are subjected to a rigid visual inspection. Test pieces are also taken from a certain percentage of the forgings and pulled to destruction. The base plates that pass inspection are trucked from the forge shop to the rough-turning lathes in the No. 2 shell shop. One of these lathes is shown in Fig. 43. In these machines the forging undergoes the twenty-fourth operation, in which it is merely reduced in diameter, no stock being removed from the face of the base-plate blank. The rough forging is shown at *A*, and the rough-turned work at *B*. The lathes are equipped with sockets *D* having a tapered square hole that fits over the shank of the rough forging. The sockets are provided with tapered tangs that are driven in the taper in the nose of the lathe spindle. Fitted in the tail spindle is a flat disk center *E*, which abuts against the face of the rough forging and holds it in the tapered socket while the cut is running. In the tool post of the lathe is an ordinary roughing tool *F*.

The operation of rough-turning is as follows: The rough forging is entered in the socket *D*, as shown at *G*, in Fig. 43. The disk center in the tail spindle is run up against the flat base of the forging, and the tail spindle is clamped. The travel of the tool is toward the headstock. Enough metal is removed to leave about $\frac{1}{32}$ in. for the finish-turning operation. A man can rough-turn from 175 to 200 small base plates per hour. One cut only is taken, and the setting of the tool is altered only after grinding and when, through wear, slight adjustment becomes necessary.

The twenty-fifth operation, which consists of finishing the base plates, is done both on engine lathes and on Bridgeport special base-plate threading machines that have been modified to do this work. The method of turning and threading base plates with the Bridgeport machines is fully described and illustrated in the fourteenth operation in the series of articles covering the manufacture of the 4.5-in. high-explosive shell and therefore need not be repeated here. Its output on the small base plate is of course higher than on the large one. On this work it is capable of turning from 12 to 15 threaded base plates per hour.

The method of holding the rough-turned base-plate forging is in both types of machines the same. The entire arrangement is to be seen in Fig. 44. Here is shown one of the Bridgeport automatic machines that has been changed over to take care of this particular class of work.

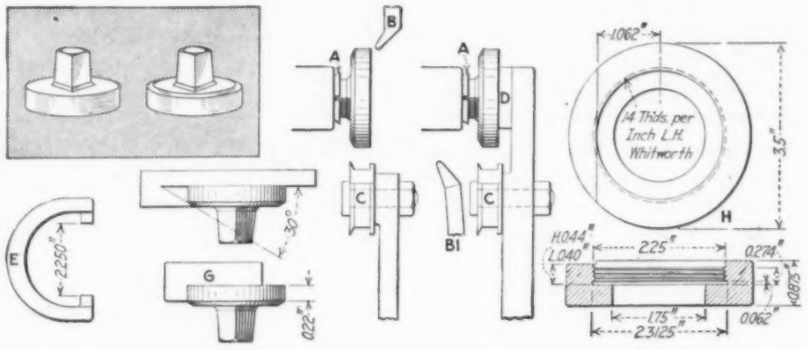


OPERATION 24. ROUGH-TURNING BASE PLATES

Machines Used—16-in. engine lathes.
Special Tools and Fixtures—Socket driver A; disk center B; turning tool C.
Gages—Snap gage D.
Production—One man and one lathe, 175 to 200 per hour.
Reference—See Fig. 43.

The spindles of the machines are hollow and provided with draw-in collets to hold the work *A*. The draw-in collet is operated by the large handwheel *B*. The rear tool block *C* is controlled by the ball handle *D*, which is mounted on a screw that passes through a hole in the screw operating the front tool block *E*. The front tool block is operated by the handwheel *F*. It carries a circular formed tool *G* of the same shape as the finished base plate.

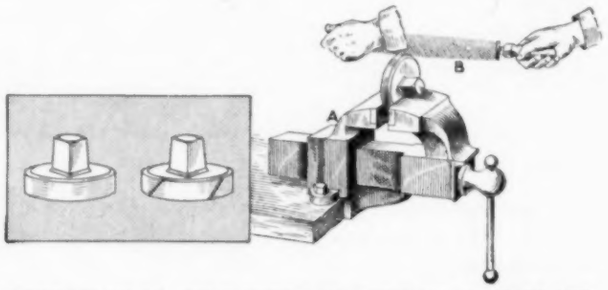
The operation of finish-turning a base plate is as follows: The rough-turned base plate *A* is chucked in the collet chuck. The facing tool in the rear tool block *C* is then brought forward by operating the ball handle *D*. When the bottom of the base plate is faced, the tool is returned clear of the work. The operator then feeds the circular forming tool *G* into the work until the stop *H* brings up against the member *I*. This determines the diameter of the work and finishes the operation.



OPERATION 25. FINISH-TURNING BASE PLATES

Machines Used—Converted Bridgeport automatics and engine lathes.
Special Tools and Fixtures—Draw-in collet A; facing tool B; formed tool C; for the engine lathes the special stop D and turning tool B1.
Gages—Snap gage E; angle gage F; height gage G; gage H for threaded base plate.
Production—One man and one machine, 75 per hour.
References—See Figs. 44 and 45.

The tools used in the engine lathes are shown in Fig. 45. They differ slightly from those used in the converted automatics. The draw-in chucks are arranged in precisely the same manner as those in the converted automatics. Owing to the fact that the lathe was close to a window, it was necessary to swing the compound slide around so that the photograph for Fig. 45 could be taken. The reader should remember, therefore, when looking at the illustration, that the compound rest is swung counter-clockwise about 90 deg. from its operating position; that is to say, the face of *C* should be at right angles to the axis of the lathe spindle and not in line with it, as is illustrated.



OPERATION 26. FILE NICKS IN EDGE OF BASE PLATE

Machines Used—None.
Special Tools and Fixtures—Machinist's vise A; half-round file B. Hand operation.
Gages—None.
Production—One man, vise and file, 60 per hour.
References—None.

At *A* is shown one of the collets with a jaw broken out, thus permitting a view of the teeth in the inner faces of the jaws. The taper on the inner faces of the jaws is 7 deg., the same as that on the shanks of the base plates.

The facing tool *B*, which is the first tool used, is set in advance of the forming tool. At *C* is a stop so located that when it is against the faced bottom of the base plate

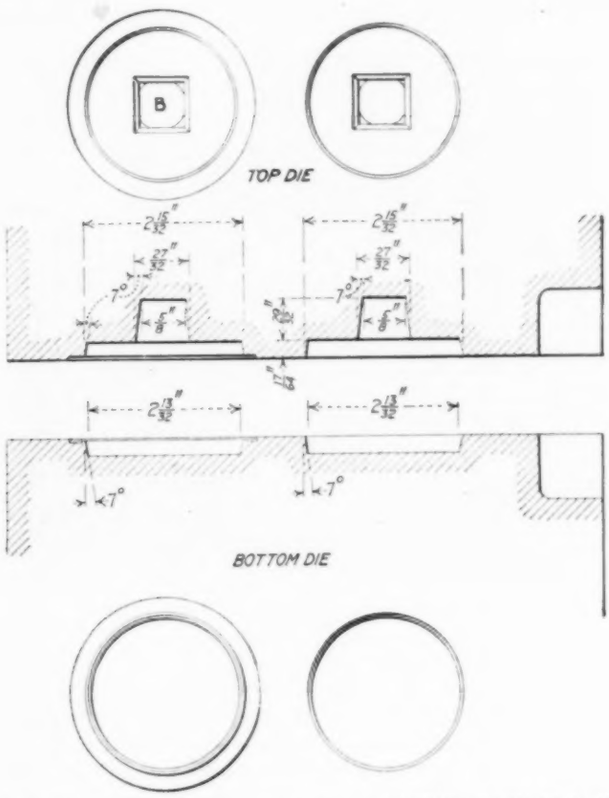


FIG. 41. DIES AND FORGING FOR RIVETED BASE PLATE FOR 18-LB. HIGH-EXPLOSIVE SHELL

the forming tool *D* is correctly located to finish the perimeter.

The operation of finish-turning a base plate with the engine lathe is as follows: The rough-turned blank is chucked in the same manner as in the converted Bridgeport automatic machine, shown in Fig. 44. The facing tool *B* is run across the base of the plate. It is then run back and the carriage racked toward the headstock until the stop *C* encounters the faced base of the work. With the carriage held in this position the formed tool *D* is fed in until the stop on the cross-slide is reached. This finishes the work.

For inspection three gages are used—a 2.250-in. snap gage for the diameter; a 30-deg. angular gage for the angular part of the work and a 0.22-in. height gage for the height of the cylindrical part. The scheduled time on the finish-turning is about 75 pieces per hour. This is about five times as fast as the highest possible production on the threaded base plate. The tools used are much more

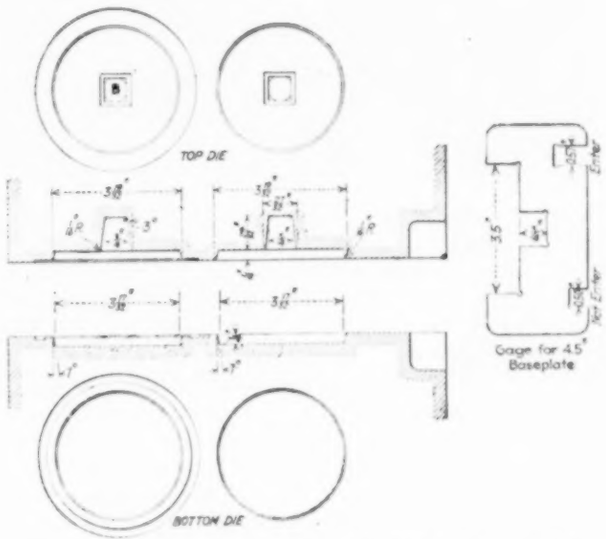


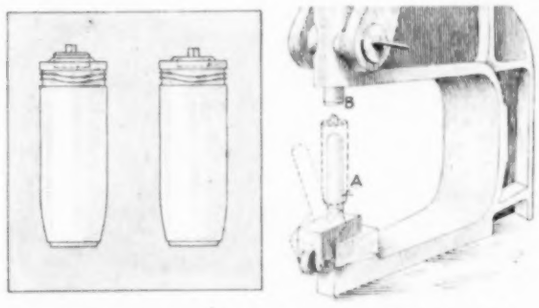
FIG. 42. DIES FOR BASE PLATE, 4.5-IN. HOWITZER HIGH-EXPLOSIVE SHELL

rugged than those used for threaded base plates and consequently give less trouble. After inspection the work is credited to the operator and trucked to the benches, where the edges are nicked.

To preclude the possibility of trapping the air in the base-plate recess when the base plate is forced home, the Government requires that the base plates have three grooves cut in the periphery of the cylindrical part. These act as vents for the release of the air. The requirement is that the nicks be cut out; that is to say, the metal must be removed, not merely wedged to the sides with a cold chisel, as is the method when the wave ribs are nicked for the same purpose in the copper driving-band groove.

OPERATION 27. ASSEMBLE BASE PLATE IN SHELL BASE

Machines Used—None.
Special Fixtures and Tools—None; hand hammer only used to enter the plates in the shell.
Gages—None.
Production—One man, about 200 per hour.
Note—No Pettman cement used with this type of base plate.
References—None.



OPERATION 28. DRIVE IN THE BASE PLATES

Machines Used—Murphy pneumatic riveters.
Special Tools and Fixtures—Tilting post A; hollow punch B to clear the shank of the base plate.
Gages—None; the hand hammer is used to test the work
Production—Two men and one machine, 200 per hour
Note—For method of assembling threaded base plate see operation 15 in manufacture of the 4.5-in. high-explosive shell.
References—See Figs. 47 and 48.

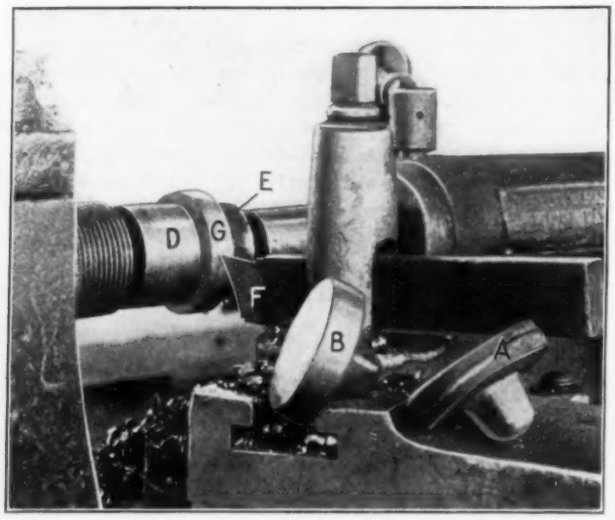
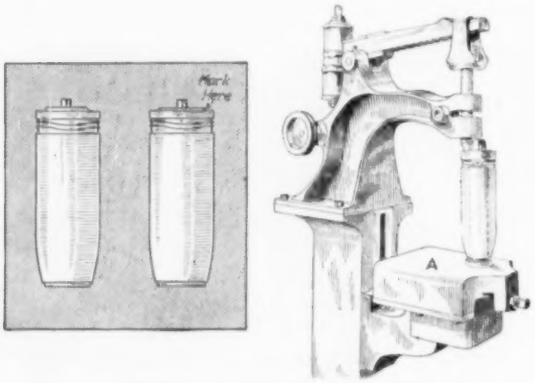


FIG. 43. ROUGH-TURNING BASE-PLATE FORGINGS

A special machine was constructed for this work, but it was found that using a file was quicker. The base plates are held in a vise, and the operator takes three strokes with the edge of a half-round file. He makes three nicks at an angle of 45 deg. with the base and approximately 120 deg. apart. This finishes the twenty-sixth operation, as there is no inspection. When done, the base plates are trucked to the bench, where they and the shell bodies are assembled preparatory to forcing in the base plate. Assembling, which is the twenty-seventh operation, consists merely of entering the base plate in the recess in the base of the shell body.

It will be remembered by those who read the series of articles covering the manufacture of the 4.5-in. high-explosive shell that the threaded base plate is smeared with Pettman cement before it is screwed in. The new type of base plate is put in dry without any Pettman cement. It may be well at this time to correct an error which occurred in the articles on the 4.5-in. shells as to the composition of Pettman cement. The composition is as follows:

	Lb.	Oz.
Gum shellac	7	8
Spirits, methylated	8	4
Tar, stockholm	5	0
Venetian red	20	12



OPERATION 29. RIVET BASE PLATE

Machines Used—High-speed hammers.
Special Tools and Fixtures—Slide and post A.
Gages—None; the hand hammer is used to test the work.
Production—One man and one machine, 30 per hour on new-type base plate; on threaded base plate, 100 per hour.
Reference—See Fig. 49.

The amount of Venetian red seems so large in comparison with the quantities of the other ingredients that one might think it an error. It merely represents, however, a quantity equal to the combined weights of all the other ingredients. Pettman cement is still used with the threaded base plates.

The screwing in of the threaded base plate is fully covered in the fifteenth operation in the series of articles describing the manufacture of the 4.5-in. high-explosive shell

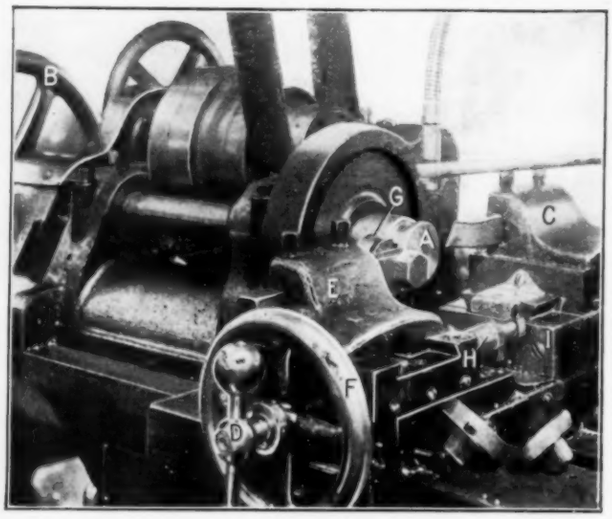
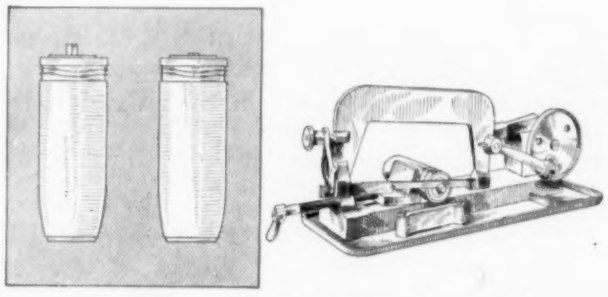


FIG. 44. FINISH-TURNING THE FORGING IN CONVERTED BRIDGEPORT AUTOMATIC MACHINES

and therefore need not be repeated here. This operation is at the Dominion Bridge Co.'s plant, done in a slightly different manner. The threaded base plate is first screwed down with a hand-operated machine, shown in Fig. 46. The gearing was designed to give a pull equivalent to a lever 8 ft. long, but it was found in practice that the final tightening was better done with the old-fashioned lever. In the illustration the machine is shown while being used



OPERATION 30. SAW OFF SQUARE STEMS

Machines Used—Racine power hacksawing machines.
Special Fixtures and Tools—None.
Gages—None; the boy operator works as close to the shell base as he can.
Production—One boy and two machines, 120 per hour.
Note—Cutting lubricant used.
Reference—See Fig. 51.

to size threaded base plates. The base plate is shown at *A* and the sizing die at *B*.

In Fig. 47 is shown a 40-ton Murphy pneumatic riveter used for the twenty-eighth operation, which is pressing in the new type of base plate. The assemblers enter the base plates in the recess in the bottom of the shell body. The shells are then placed on a bench convenient to the operator of the riveter. The post *A*, Figs. 47 and 48, is

hinged so that it can be tilted forward for placing and removing the shell.

The operation of forcing a base plate into the shell base is as follows: The operator slips a shell over the post *A*, which is tilted toward him, as shown by dotted lines in Fig. 48. The post and shell are then pushed back until the heel of *A* rests on the plate *B*. When in this position the post *A* is vertical and its axis is in line with the axis of the plunger *C*. The air valve is then opened, and the

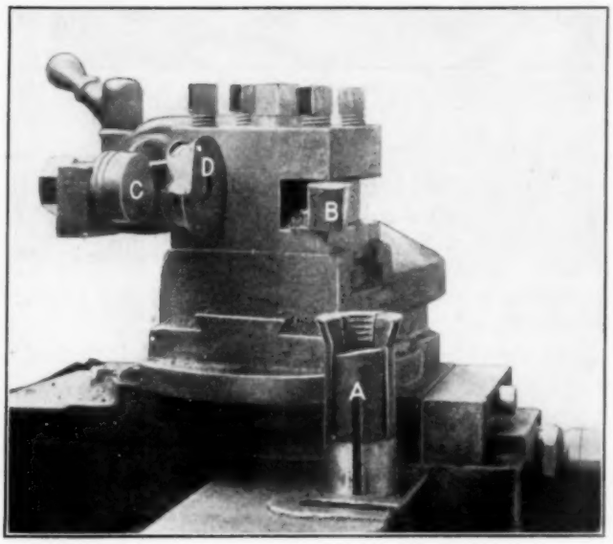


FIG. 45. BASE-PLATE TURNING TOOLS AND COLLET FOR THE ENGINE LATHE

piston of the air cylinder comes forward, forcing the plunger *C* downward. One or two strokes of the plunger are sufficient to force the base plate firmly to its seat in the recess in the shell base. Details showing how the Murphy riveter is arranged are given in Fig. 48.

The speed of handling depends on the men and not on the machine. Two men handle the job, and they can

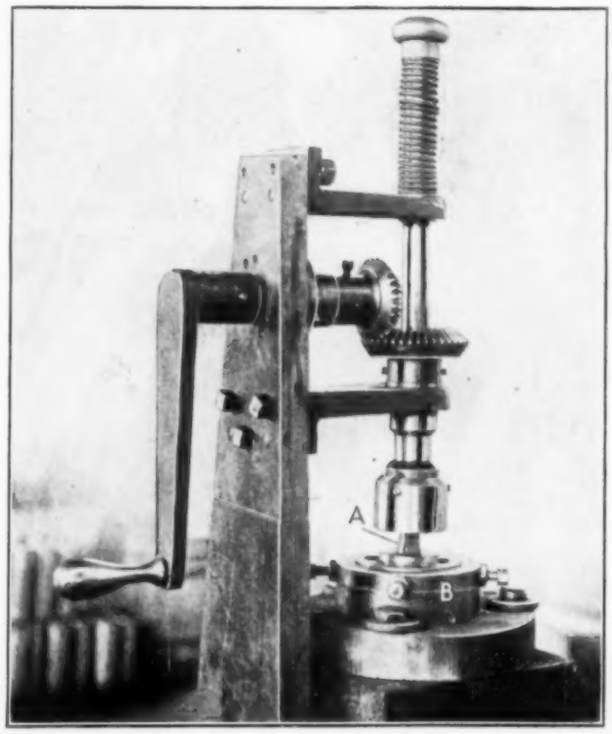


FIG. 46. MACHINE FOR SCREWING IN THREADED BASE PLATES

hammers, shown in Fig. 49, where they undergo the twenty-ninth operation. The helve hammers used are of the type built by the High Speed Hammer Co., Rochester, N. Y.

At *A* is shown a shell as it comes from the previous operation, and at *B* as it appears after the base plate is riveted in. The machine is provided with a vertical post *C* on the sliding table *D*. The alignment of the riveting flange of the shell, with relation to the riveting punch *G* when in riveting position, is determined by the stop *E*.

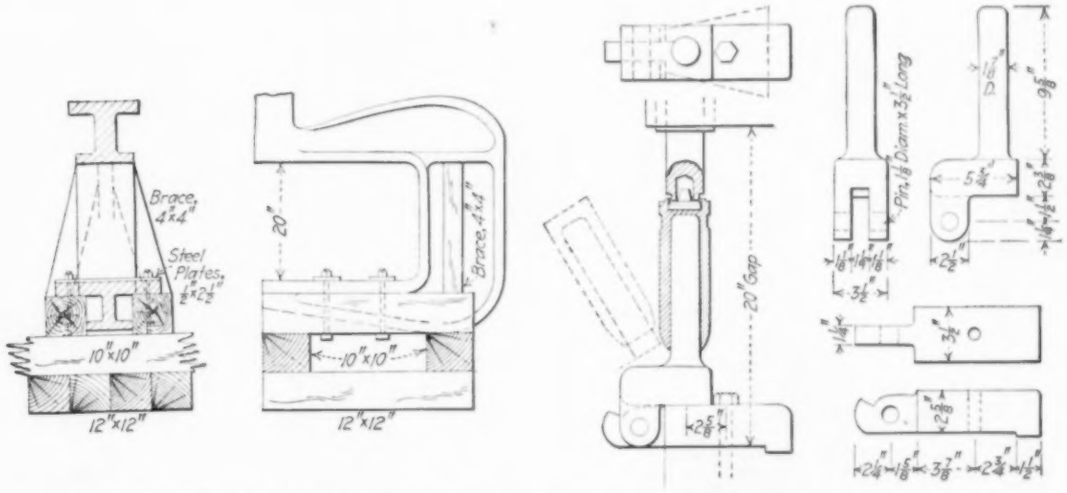


FIG. 48. DETAILS OF MURPHY PNEUMATIC RIVETER FOR FORCING IN BASE PLATES

press in 200 base plates per hour. After being pressed in, a Government inspector tests each base plate with a hammer blow. Any that sound hollow are removed, and slightly larger ones are fitted and driven in. From the Murphy riveter the shells are trucked to the riveting

When this is in contact with the knee of the machine, the riveting flange on the shell is correctly located. The speed of the hammer is controlled by a foot lever so that many or few blows, depending on the foot pressure, can be given in a certain space of time.

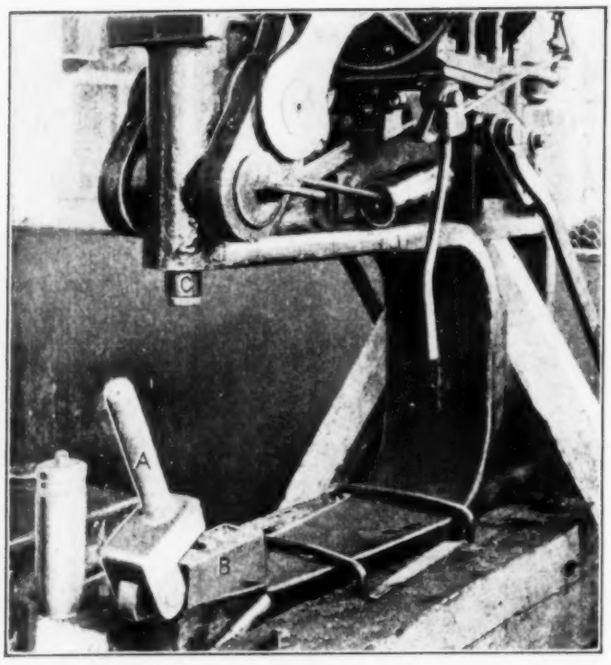


FIG. 47 MURPHY PNEUMATIC RIVETER FORCING IN BASE PLATES

The operation of riveting is as follows: The operator slides the table *D* toward him and places a shell from the previous operation, as shown at *A*, over the post *C*. The table is then pushed away from him until the stop *E* brings up against the front of the knee *F*. The operator then depresses the foot lever, and the hammer is started. With both hands embracing it, the shell is slowly revolved on the post until practically all the metal in the riveting flange is driven down onto the angular part of the base plate. Riveting the new type of base plate can be done at the rate of about 30 base plates per hour. Riveting the threaded type of base plate is done much more rapidly,

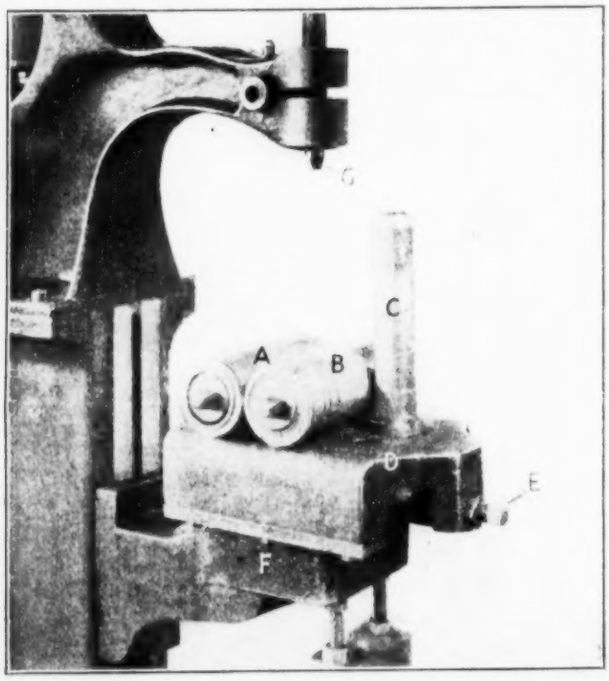


FIG. 49. HIGH-SPEED RIVETER FOR BASE PLATES

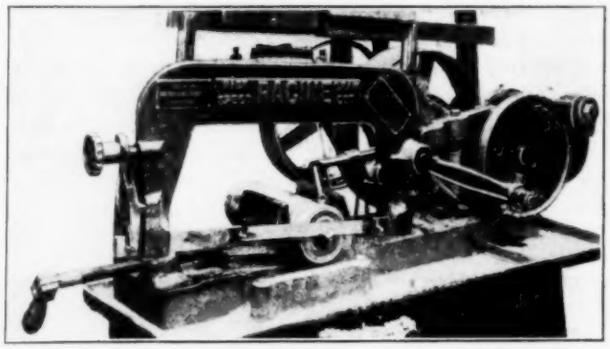


FIG. 51. HACKSAW SAWING OFF SQUARE SHANKS

as there is less metal to displace, and the scheduled time on this work is 100 base plates per hour. When run continuously at high speed, the riveting hammers are apt to heat up so that they cannot be run satisfactorily. This reduces the output. With hammers that could be run continuously a considerably higher output per hammer should be possible.

At a time like this, when tools are so difficult to obtain, it behooves every man who is responsible for results to make use of every possible expedient by which he can keep up production while waiting for special or other machines. In Fig. 50 is shown a simple arrangement of an ordinary pneumatic riveting hammer for handling this work. The hammer *A* is supported on the rolled-steel frame *B*. The thrust of riveting is taken by the yoke and springs *C*. The hammer is supported by the yoke lever and weight *D*. It would seem that a spring instead of a weight would make a better and more elastic support as the inertia of the weight is apt to give trouble. The shell *E* is placed over the post *F*, which forms a part of the swinging member *G* pivoted at *H*. When inserting or removing the work, the member *G* is swung to one side, as shown by the dotted lines in the detail. A stop *I* on the table determines the position of the member *G* when it is in operating position. After riveting, the work is visually inspected and also given the hammer test. The shells are then credited to the operator and trucked to a bank of Racine hacksaws, where they undergo the thirtieth operation. In Fig. 51 one of the

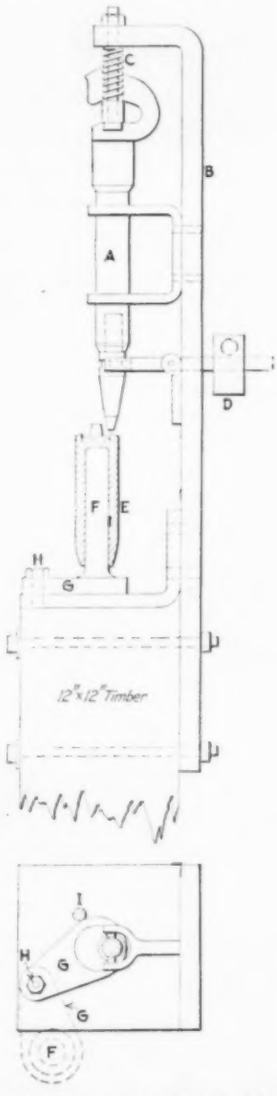


FIG. 50. PNEUMATIC HAMMER ARRANGED FOR RIVETING

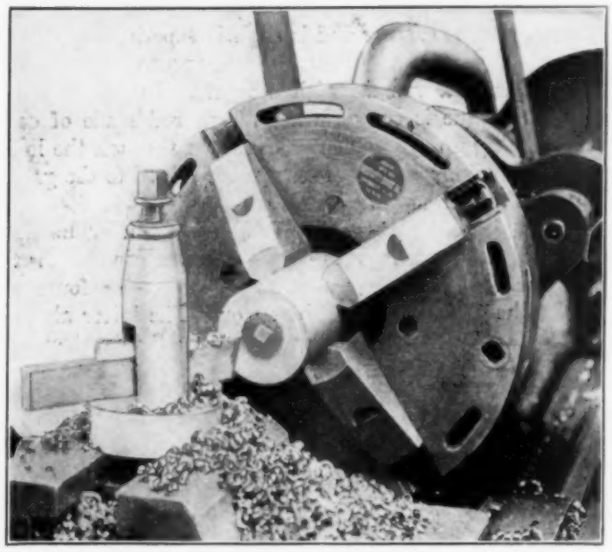
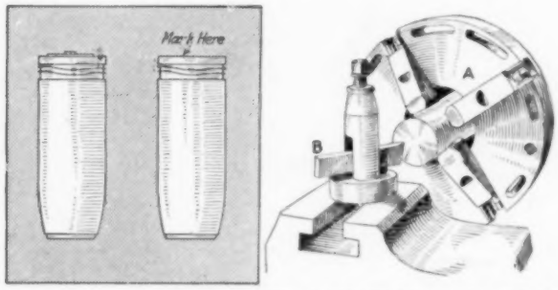


FIG. 52. FACING BASE PLATE AND BASE IN ENGINE LATHE EQUIPPED WITH COMBINATION CHUCK

saws is shown with a cut part way through the square shank of a base plate. One boy runs two machines, and they are never stopped except to renew saw blades. The time for sawing is one minute from floor to floor, so the boy's output should be nearly 120 shells per hour.



OPERATION 31. FACE THE BASE PLATE AND BASE

Machines Used—Engine lathes 20 in. by 6 ft.
Special Tools and Fixtures—Combination chuck A; facing tool B.
Gages—None.
Production—One man and one machine, 30 per hour.
Reference—See Fig. 52.

After the stems are sawed off, the shells are trucked to 20-in. engine lathes, one of which is shown in Fig. 52, where the base plate and the base of the shells are faced off. This constitutes the thirty-first operation. The lathes are equipped similarly to those used in operation 12. From three to four cuts are necessary to face the bases correctly.

Making Tools for a Die Casting

By W. Eastman

In this article will be described the operations performed when making the dies for forming the die casting, Fig. 1.

The first thing to do is to square up the two blocks of steel that comprise the die, Fig. 2. The die maker then lays out the four ½-in. dowel-pin holes. These are drilled and reamed all the way through while clamped together in a drill press. The dowel pins are hardened and drawn to a straw color and then driven into position in either block. This block is then known as the bottom die.

The dowel holes in the upper die block are now reamed with an expansion reamer, so that the dowels will slide easily. Then both blocks are put in the shaper together and the sides planed off. Care must be taken to have the two sides perfectly square and square with the face, from which all layouts are made. Both faces of the die blocks are coppered and the center lines scratched in with a height gage.

Construction of Lower Die

The two parts of the die are now bored. The upper die contains the two smaller diameters of the article. Extreme care must be taken to bore these sizes to a smooth surface, leaving a little clearance. In this case 0.007 in. was allowed for shrinkage. A spring tool holder is used for the finishing operation. All holes in a die are bored straight, since the metal will shrink away from the hole; but all cores are tapered about 0.010 in. and draw-filed.

Since the lower die contains the core *A*, it is obvious that it must be provided with a core seat. This is done by counterboring the bottom of the die hole to a depth of

FIG. 1. THE DIE-CASTING MADE

about $\frac{3}{16}$ in., into which the core fits snugly. The core *A* is draw-filed all over after fitting into it the key *B*, which is held in position by means of small screws reaching in from the bottom.

The boss *C* is $\frac{3}{32}$ in. high. This must be remembered when the lathe operation is being performed. The die is set up on a miller having a vertical attachment. The surface of this boss is the dividing line of the crank *D*, which has a $\frac{3}{16}$-in. hole cored through the knob *E*. A stationary core *F* is fixed in the upper die for this purpose.

The boss *C* has sides at an angle of 45 deg., so that there will be room for the side cores *G* and yet reinforcement for that section of the boss where the crank is joined to the cylinders of the casting. Such reinforcement is necessary on dies for aluminum; otherwise, after several hundred castings are made the slim section would oxidize and disappear, compelling early repairs.

The section of the core hole shown at *G* must not be longer than about $\frac{5}{16}$ or $\frac{3}{8}$ in., because these sections are

drilled and reamed from the finished core block *H*, which is accurately made by first drilling and reaming, then turning on an arbor, making a sliding fit into the lower die block. The die blocks are held in position by means of flat-head screws reaching up from the bottom. The cores are made a sliding fit into the core blocks and extend out to be secured to the adapter *I*. That section of the core marked *G* is made 0.010 in. larger than the end that enters the casting, because, after a number of castings are made, particles of aluminum become attached to the core and tend to scratch the core hole in the die block.

Referring again to the core blocks *H*, the reader might ask why blocks are provided. The answer is that it is almost impossible to bore small core holes all the way in from the sides and have them come out exactly central. Therefore, large holes to be filled with blocks are bored first, and after the blocks are inserted the small hole is transferred from the blocks.

In order to set the dies up properly so as to get the holes at accurate angles, the lower die was set up first by means of clamps which entered $\frac{3}{8}$-in. holes $\frac{3}{8}$ in. deep, drilled into the sides of the lower die blocks for the purpose. The upper die was laid in its proper position on the lower one and the whole securely clamped to the miller table. The knob *F* was next milled, the position being obtained by a bevel protractor to set up each die block so that $\frac{1}{2}$-in. feeler pin projecting out of the milling-machine spindle could be measured so many thousandths away from the die hole. The next operation was milling the crank space, which in cross-section is shaped something like a cross-file. A special cutter is necessary for this purpose. It is easily made, being nothing more than a drill rod of the size required. It is turned in a bench lathe to the needed shape to a templet, and then milled or shaped like the tang of a taper-shank twist drill. The cutting edges are then backed off, and the tool is hardened.

In order to mill the ares of the crank it was necessary to set up the dies on an auxiliary revolving table, graduated in degrees and operated by a worm. The center of an arc is located concentric to the revolving table. This revolving table being graduated in degrees, it is an easy matter to locate the positions of the lugs and small core holes in the cylindrical section.

Water jackets *J* are provided in most dies for aluminum castings. They are not needed in dies for soft-metal castings, since most soft metals melt at 700 to 800 deg. F., while aluminum requires a much greater heat, depending on the alloy used. Water pipes are connected by means of rubber hose and nipples screwed into seats *K*. The hole *L* is drilled from the side in order to complete the jacket and is plugged up by the plug *M*.

The sprue hole is placed in the upper die about $1\frac{1}{4}$ in. away from the casting and is slightly tapering toward the dead side of the die. In this case the sprue was twisted off and allowed to remain with the gate. In various other dies the sprue is cut off with a long rod made of cold-roll passing up through the ejector box through the lower die and striking the sprue where it is joined to the gate—a sort of punch-and-die operation.

The ejector box is made of cast iron. The view shows the front legs broken off on a line with the top surface of the box at *O*, which contains four pins *P* for the ejector plate *Q* to rest on. The latter also has four pins *R* for the core bracket plates *S* to rest on and operates the levers *T*. The operations follow:

The handle *U* and pinion *V* are a unit to operate the rack *W*, which raises the plates *S*. The joints *X* are joined to the links *T* by means of $\frac{3}{8}$-in. pins. The upward movement of the studs causes the adapter *Y* to pull out the side cores *G*. Safety pins *Z* are provided so that the casting may not be ejected before the cores are pulled out. The pin *Z* cannot rise until a hole is partly made in the core above it, which is done when the core is pulled all the way out.

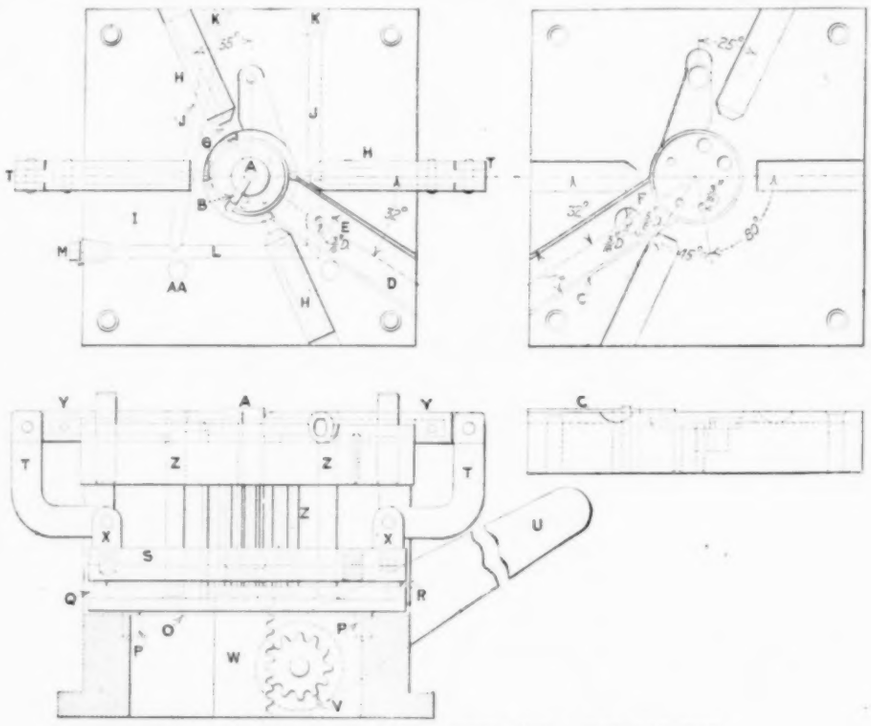


FIG. 2. DETAILS OF TOOLS USED FOR A DIE CASTING

The safety pin is a member of the gang of ejector pins surrounding it. They are all operated by a handle *T* actuating a rack. The handles move in opposite directions. All the ejector and safety pins pass through clearance holes in the plate and through the die block to within $\frac{1}{4}$ in. of the surface, when they must fit snugly. *AA* is another safety pin, two of which are generally provided and laid out just about where they are shown. These are furnished to make sure the ejector pins do not butt against the casting before the upper die block is removed. Should the workman operate the ejector-plate handle before he separates the die blocks, then these safety pins will separate and the casting will be ejected, as the safety pins and ejector pins are secured to the same plate.

Painting Small-Shop Products--II

By John H. Van Deventer

SYNOPSIS—Brush painting and air drying of the painted articles comprise the process most common in the small shop. This article describes various methods of applying filler, flat finish, semigloss and full gloss. It also gives practical points in caring for brushes and securing freedom from dust.

There is an unfortunate and very general tendency to use paint as a means of covering up defects instead of regarding it as a means of emphasizing high-quality workmanship. A manufacturer of small hardware, for example, will tolerate sandy castings, with the expectation that Old Doctor Paint will apply his universal remedy for rough surfaces and make a healthy specimen out of each decrepit invalid. Wrinkled and scratched products of the drawing press get by, in the hope that they will become respectable and presentable beneath a few coats of black japan. Certain products of the woodturner's art (or, rather, lack of it) go into the dipping tanks fringed with wooden whiskers that must be rubbed off by the painter, who is thus forced to add the profession of barber to his other accomplishments. This policy has made machinery painting much more expensive than it needs to be, because both painter and paint must do work that has been left undone by someone else. They are the ultimate correctors of all the sloppy jobs that go through the shop.

How much more does it cost to produce a smooth casting in the foundry than to make it smooth in the paint department? Balance the cost of good facing and a few moments' slicking of the mold against the cost of knifing on two coats of filler and currying them with sandpaper and rubbing bricks. How much longer does it take to get smooth products from the drawing press than scratched and wrinkled ones? How much longer does it take to sandpaper wood turnings in a tumbling barrel before they are painted than to rub down the irregularities after the first coat? Getting these things right in the first place costs less in money, but more in care—which is a scarce article in a good many shops.

What Constitutes a Painting Department

A small-shop painting department may be a simple or an elaborate affair, according to its needs. But to be a success, it must be regarded as a real department, even if the equipment consists only of a putty knife, two brushes and a few cans of paint. It must be regarded as an institution worthy of existing for what it does, and not as a necessary but unpleasant evil. And for the same reason, the work of painting should be done by the same man, even if there is not enough of it to keep one man continually busy. This is the only way that real interest in the work can be created and maintained, and interest is as essential a part as is the paint can or the brush.

One of the greatest handicaps to a good painted finish is dust. A machine shop is sure to have plenty of it on hand at all times, no matter what other commodity is short. Fresh paint and varnish seem to attract it as a magnet draws iron filings, with the difference that the filings can be removed, but the dust cannot. It sticks, and spoils the finish.

There are two ways of overcoming the dust disadvantage, both of them based on not letting it get on. The easiest and most common way, and quite naturally the one with lesser merit, is to shorten the drying time by the addition of drier, so that the period in which dust can settle and stick is decreased.

The second and better way is to have a separate room for painting, at least for the final coats. Don't throw up your hands at this point, Mr. Small-Shop Man—there are more ways than one of killing a cat or of making a paintroom. I have known small-shop owners with offices that were more ornamental than useful who moved their desks out into the shop, and their pails and brushes into the office, with beneficial results both ways. Sitting in an office chair does not buy the small-shop baby new shoes, and dust works less injury to bills payable than to painted products.

Compromising on a Canvas Curtain

In one shop, where it was felt that a separate room for painting could not be provided and yet the necessity for it was known, a satisfactory compromise was made by providing a canvas curtain that partitioned off the assembling floor from the rest of the shop. The curtain was kept rolled up until required; when dropped down while painting a machine, it had a noticeable effect in decreasing the amount of dust.

Dust works its way through shop ceilings; and when this condition must be avoided, the ceiling may be either filled and painted, thus stopping the cracks and the dust leakage, or it may be covered with sheet iron, provided the fire-inspection regulations will permit.

The dust which settles on a coat of paint that has dried sufficiently to lose the quality of stickiness should be removed before the next coat is applied. It would seem that this is so self-evident as to be hardly worth mentioning, but it is a precaution that is overlooked in many shops. Compressed air is the best dust remover, and a hand bellows will act as an air compressor and hose combined in the shops that do not have compressor installations.

Much could be said on the subject of the proper size and kind of paint brush to use for a given purpose and a given paint; but you will find that experienced painters have different views in the matter, and even among them there is little agreement. No scientific study of this subject seems to have been made, and little, except opinions, can be offered. There is one thing, however, that is beyond contradiction—the size of the brush should be in proportion to the size of the work. By size is meant paint-carrying capacity. An oval brush will carry more paint or varnish than a thin flat brush that is wider in dimension. A brush is really a paint conveyor working back and forth between the pail and the painted surface, and the fewer round trips that it must make to cover the job the higher will be its conveying efficiency. As far as helping to produce a smooth finish, the brush itself is of little importance, properly dipped work being as excellent in this respect as the most skillfully applied brushwork.

The matter of caring for brushes has been much more definitely worked out. It was my privilege recently to hear the views of Carl J. Schumann, of the Moller & Schumann Co., Brooklyn, on this and other points relating to metal finishing. In the matter of caring for brushes this firm has evolved what it calls a "brush keeper," which is a closed metal can in which brushes are held suspended in a solution of linseed oil and turpentine. The brushes are placed in this can after being properly cleaned in clear turpentine. Thus they are kept in first-class condition, ready for use. The instructions for using this device are as follows:

When through using your brushes, rinse them thoroughly in turpentine, then put into the brush keeper.

In the brush keeper use a mixture of about four-fifths raw linseed oil and one-fifth turpentine. As the oil shows signs of thickening, which practically means that the turpentine has evaporated, add more turpentine.

Empty and clean out the keeper at least once a month. Strain the contents through two thicknesses of cheese cloth and make good any deficiency with a mixture in the same proportions as the original.

When brushes hang in the keeper, make sure that they are at least 1 in. clear of the bottom and also clear of the sides and of each other.

Rinse the brush in turpentine after taking it from the brush keeper; and before putting it into the varnish cup, discharge the turpentine from the brush by drawing it once or twice across the wire, then shaking briskly.

Fill the brush with the varnish in the cup, draw over the wire once or twice, immerse again in the varnish and let it stand for a short time. The brush is then ready for use.

Keep the varnish cup at all times protected from dust.

Closed Paint Cans Economize on Material

Waste and evaporation take a greater percentage of paint in the small shop than in the large one. A can of paint may be used one day and then set away for a week, often without being tightly covered. This is especially true of those cans which are opened by cutting the top. A simple cure for this waste is at hand in all shops and costs nothing. If you are up against a case of this kind, put a sheet of paper over the top of the can, fold it down over the sides and tie a string around it. It will look like an old-fashioned can of mother's marmalade, but the contents will keep indefinitely, so appearances may be overlooked.

The customary method of applying filler by knifing it on the casting requires a fair degree of skill to produce a smooth job. A better way in the small shop is to use the "benzine" process, which is as follows: The filler is first reduced with turpentine to a stiff paste, using a round brush. A second and a third coat are applied in the same way, before the first coat has had time to dry. Three or four hours are then allowed for the filler to take hold, after which it is rubbed down with a piece of heavy felt soaked in benzine.

It is quite a common belief that priming, filling and rubbing are essential to a high-grade finish. Some machinery builders proclaim in their catalogs that their machines are given so many coats of filler and rubbed down after each coat, as if the application of filler and the elbow grease necessary to rub it were things that no self-respecting high-grade machine could do without.

If the notion that finish is a covering of imperfections, as mentioned in the first paragraph, did not exist, you would hear less about the primer and filler. Defective and rough surfaces necessitate filler, and this in turn calls for primer to make it stick. If you attempt to fill a porous surface that has not first been primed, the result will be disastrous, as the binding element in the filler will be absorbed, leaving it without adhesive power and likely to flake off, carrying with it whatever paint and varnish have been applied. Neither primer nor filler is a necessary part of a good finish—neither of them adds one bit to its quality. Both are substitutes for a suitable surface on which to apply color and varnish. If you have the smooth surface to start with, no amount of these substitutes will better the finish; in fact, they will make it worse, for two coats will very often stick better than six. We cannot do away with filler and primer on many kinds of work, but at least we can give them their proper value as defect and roughness coverers.

Three Classes of Brush Finish for Machines

There are, omitting black asphaltum and other more or less temporary coatings, three classes of brush finishes for machine shop products. These are the flat, the eggshell, or semigloss, and the full-gloss finish. The suitability of each of these for certain classes of work was mentioned on page 183, in the preceding article. Priming and filling, when necessary, are the same, no matter which of these final finishes is to be used—which is another argument for regarding priming and filling as restricted to the preparation of the surface for finishing and not as a part of the finishing itself. In describing these three finishes I will assume that this preparatory work has been completed and that the surface is ready for color.

A flat finish may be obtained in one coat of color, but it will not be anything to brag about. Two coats, however, will produce a first-class flat-finished job, providing the materials used are of good quality. Give the first coat 24 hr. to dry, whenever possible, even if it means holding back the shipment one day—the customer won't kick if you come that close to keeping your promised date. In this connection beware of paint bargains.

The semigloss finish requires more skill to apply and get right than either of the others. The coat underneath the eggshell or semigloss must be impervious, as otherwise the soluble matter in the semigloss is absorbed in spots and the result is crude. A coat of full-gloss enamel will provide the necessary surface on which to put the eggshell finish, but it must be allowed to dry thoroughly before this finish is applied.

Full gloss can be obtained in two coats of enamel. Usually, a "first-coat enamel" and a "finishing enamel" are applied, the supposition being that these two must be of different composition to produce the best results. This is another of those wrong guesses, for equally good results can be obtained by using finishing enamel for the first coat, thinning or reducing it with turpentine. It does not pay the small shop to stock first- and second-coat enamels, the wastage and extra investment more than making up for the slightly greater cost of the finishing material.

The expense of applying brush finish and the length of time required to air dry put a limit to the number of coats that can be applied under these conditions. A first and a finishing coat of good quality enamel will produce a full-gloss finish that will reflect credit on the small-shop product, unless it is a machine of such high grade as to require a number of coats, with each one rubbed. When that is the case, however, one must look to dipping and oven drying for means of shortening the time and labor, as otherwise the shipment of small-shop products would be sadly delayed.

Power-Press Accidents

By C. B. Hayward

Many serious accidents occur on power presses; and although much has been done to prevent a great many of them through the installation of safety devices, there seems to be no remedy that will eliminate them all. The market is flooded with safety devices for this type of machine, all supposed to be "sure cures"; but still there are fingers lost and hands mangled, and no satisfactory reason is given. Injuries received while working on a guarded press bring forth the ever ready statement that the guard failed to work properly. This is not so in many cases. The guard is not necessarily at fault, neither is the operator. It is the press-clutch mechanism that needs attention.

When an injury is attributed to the punch press, an examination following as the result of the accident generally renders the following verdict: "The operator must have been out of time in feeding the work into the die of the press, and the punch came down, catching his fingers, directly due to his putting his foot down on the treadle at the wrong time." This deduction may be correct in some instances, but not so in a great many; especially is it wrong in cases where a standard guard is used. Safety devices that are attached to presses and place a bar or partition between the operator and the punch or make necessary the using of both hands to operate the press will prevent the old "out of time" accident.

The workman, when he states that the gate fell a second time, is speaking the truth in most instances. Why? Because that is just what happens. It is possible for the gate to descend twice in succession, even though the treadle has been released and the cam allowed to spring back in position in order to pull the clutch pin out of the yoke collar and flywheel driving the eccentric shaft and ram. The failure can be definitely located at this one point. The pin sticks in the flywheel or collar and does not respond to any cam action, but simply forces the cam out of place and goes by, resulting in the sending of the punch down a second time without the assistance, and to the surprise, of the operator.

Safety stops placed on the cam mechanism are a necessity on presses that are operated only after the placing of each separate piece of work. They serve their purpose, but they are nothing more than automatic treadle releases making certain the placing of the cam in position for working the pin from its position in the collar. If the pin fails to work out on the cam, it jumps the cam, the same as in the case of a press without such a stop.

In some shops positive locks have been attached to the cam levers, causing the cam to remain in positive position after being released by the treadle or the safety automatic mechanism. The intention here is to keep the cam in place and make it force the pin out of the collar and flywheel, where perchance it might stick. This plan has never proved successful. The pin, refusing to be moved and not being able to jump the cam, is broken off, and the gate is sent downward on its second stroke. This sort of accident not only results in the punch descending twice in succession, but breaks part of the machine in accomplishing the act.

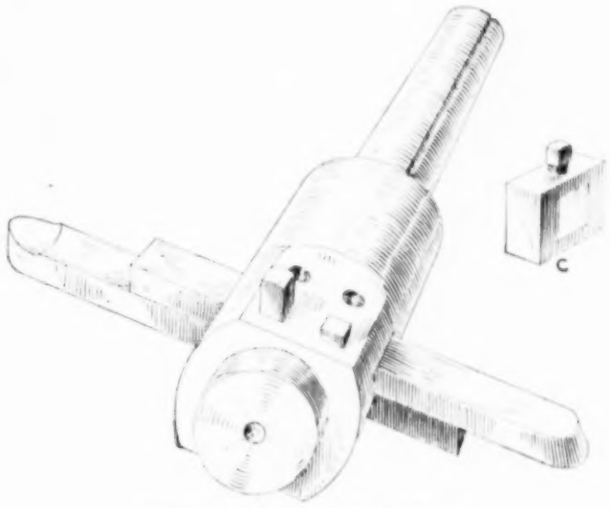
Therefore, as there seems to be no feasible and practical way of preventing the "falling gate," it is up to the man running the press to keep his hands out from under the punch as much of the time as possible. He must keep the clutch pin well oiled. He must be careful to wait long enough between taking the finished work out of the die plate and feeding in the next piece to ascertain if the gate is up to stay. This latter practice is a difficult proposition indeed and requires the watchfulness of a careful man. But that is exactly what safety stands for, and it is through carefulness that we hope totally to obliterate many of the present serious injuries received in power-press accidents.

Old Cutters in Boring Bars

By Ralph G. Noble

Having quite a lot of old boring-bar cutters which were not always of the size desired, I devised the boring bar shown in the illustration as a means of utilizing these cutters and avoiding the necessity of buying high-speed steel at the present prices.

As will be seen, I make the slot of double thickness and use two cutters. This has the advantage of reaming each cutting line at the center line, and it also makes it easy to set the cutters central and to size. By making the bars of a standard diameter it is only necessary to measure the distance from the bar to the edge of each cutter. The only disadvantage is in the slot of double width, which prevents its use in a very small bar. But on work of 6 in. in diameter and upward there is no difficulty whatever.



OLD CUTTERS IN BORING BARS

Two keys must be used, one to hold each cutter, in order to secure best results. When long cutters are used, clamps should be put over them, as shown at *C*, in order to prevent vibration and help to stiffen the cutting edges. If no pilot is to be used, I would put the two setscrews in the end instead of keys and use a block in front of the cutters for the screws to bear against.

We use two 4-in. cutters in a 6-in. bar and can bore from 6 to 7 in. with the same cutters. We recently used this type of bar to bore an 8¼-in. hole in hard bronze, taking a ⅛-in. cut.

Machining the Inking-Mechanism Details for a Press

By Robert Mawson

SYNOPSIS—In this article are shown the jigs used in machining some of the details used on a printing press. On these tools it will be seen that the object aimed at has been to make them simple and quick in operation. This effect has been attained by using fastening screws fitted with pins so that the operator can place the casting in position and hold it without the use of a wrench. Where setscrews have been used, sufficient pressure can be obtained by the fingers.

The two-sheet rotary printing press manufactured by the United Printing Machinery Co., Woonsocket, R. I., was illustrated and described on page 58. Some of the tools used—examples of modern high-grade small-tool construction—were shown on page 138. In this article other jigs of equally high-class design for machining four other details used on the inking mechanism are considered.

The parts include the vibrator-wormwheel casing—Fig. 1 of facing page; vibrator-wormwheel, Fig. 4; inking-mechanism gear guard, Fig. 6, and vibrator frame-lifting shaft cap, Fig. 8. The operations are all drilling and reaming. The tools include two jigs for the first-mentioned piece and one for each of the others. The drilled holes range in size from $^{25}/_{64}$ in. to $2^{7}/_{64}$ in. The reamed holes range from $\frac{3}{8}$ in. to $2\frac{1}{8}$ in.

Attention is called to the production times given in connection with each one of the jigs shown on the facing page. These are 15 min. each per piece for the two jigs used for the part shown in Fig. 1 and 30 min. each for each one of the tools used on the three other parts.

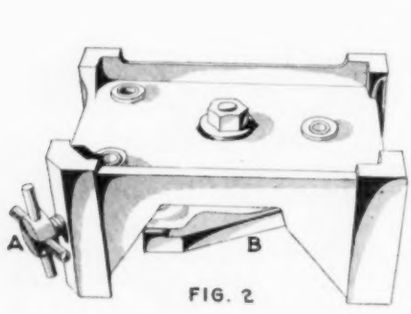


FIG. 2

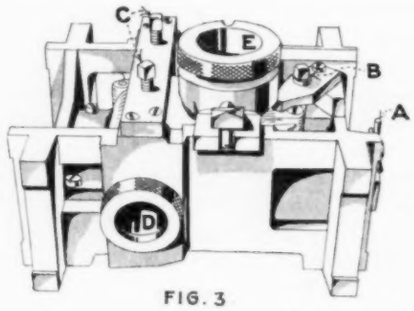


FIG. 3

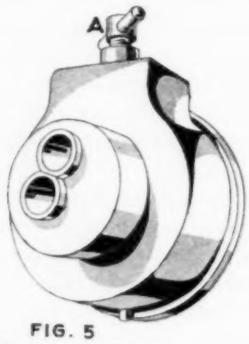


FIG. 5

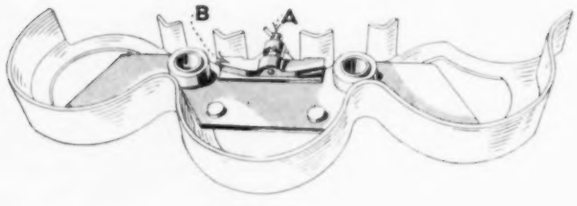


FIG. 7

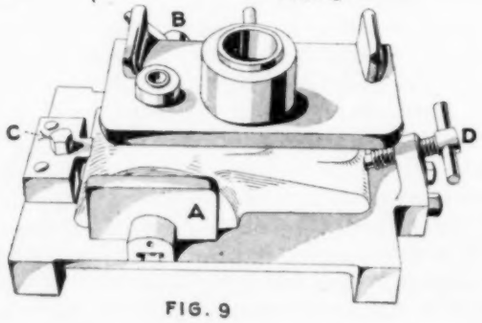


FIG. 9

DRILLING JIGS FOR MACHINING INKING-MECHANISM DETAILS, WITH WORK IN POSITION

FIGS. 2 AND 2-A

Operations—Drilling and reaming holes in vibrator wormwheel casing, Fig. 1. The casting, which has been previously milled on the parting line, is forced against an adjustable setscrew and located by a steel V-block by the pin-headed screw A. The plate B, tightened up by a nut, holds the casting in position.

Holes Machined—Two $^{25}/_{64}$-in. drilled and one $\frac{3}{8}$-in. reamed in one hand, and three $\frac{1}{2}$-in. in the other hand. On the latter casting the holes are then tapped with $\frac{5}{8}$-in. United States standard threads; on the former casting they are counterbored $\frac{7}{8}$ in. in diameter and $\frac{3}{8}$ in. deep.

FIGS. 3 AND 3-A

Operation—Machining gear, driving and driven shaft, and holes in vibrator wormwheel casing, Fig. 1. The castings—one left- and one right-hand element—are fastened together with three $\frac{5}{8}$-in. fillister-head setscrews. The part is located in the jig by two adjustable screws placed to form a vee, the casting being forced against them with the pin-headed screw A. Strap B and screws C hold the part in position.

Holes Machined—A $1^{25}/_{64}$-in. drilled and a $1\frac{3}{8}$-in. reamed at D, and one $2^{7}/_{64}$-in. drilled and one $2\frac{1}{8}$-in. reamed at E.

FIGS. 5 AND 5-A

Operation—Drilling holes in vibrator wormwheel, Fig. 4. The machined gear is placed in the jig and forced back into position with a brass shoe operated by the pin-headed screw A. A shouldered cover is then dropped into the open end of the jig and held with the headless setscrew B. The purpose of the cover is to hold the piece from sliding out of the jig during the drilling operation.

Holes Machined—Two $^{25}/_{64}$-in. drilled.

FIGS. 7 AND 7-A

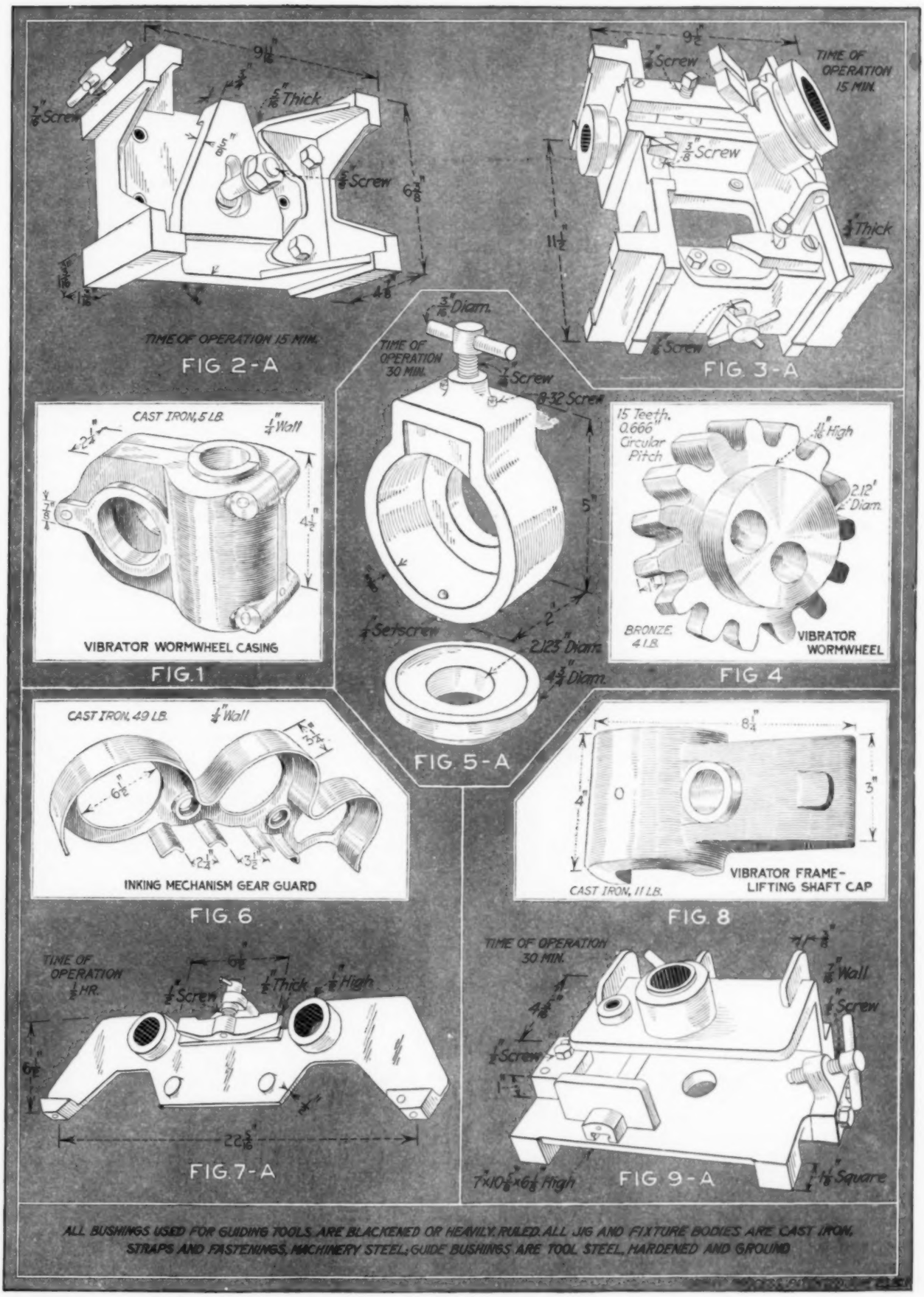
Operations—Drilling and reaming holes in inking-mechanism gear guard, Fig. 6. The jig is placed in the rough casting and the pin-headed screw A tightened. It comes in contact with the equalizing clamp B and forces the lower arms of the jig and ends of the clamp against the casting, thus holding it.

Holes Machined—Two $1\frac{1}{4}$-in. drilled and reamed.

FIGS. 9 AND 9-A

Operation—Drilling holes in vibrator-frame lifting-shaft cap, Fig. 8. The milled cap is slid into the jig and the open plate A dropped down as shown. The casting is then forced against this plate with the pin-headed screw B and against the stop C with the screw D.

Holes Machined—One $1\frac{5}{8}$-in. drilled and one $\frac{3}{8}$-in. drilled.


TIME OF OPERATION 15 MIN.
FIG. 2-A
TIME OF OPERATION 15 MIN.
FIG. 3-A
CAST IRON, 5 LB.
VIBRATOR WORMWHEEL CASING
FIG. 1
TIME OF OPERATION 30 MIN.
FIG. 5-A
15 Teeth, 0.666 Circular Pitch
BRONZE, 4 LB.
VIBRATOR WORMWHEEL
FIG 4
CAST IRON, 49 LB.
INKING MECHANISM GEAR GUARD
FIG. 6
CAST IRON, 11 LB.
VIBRATOR FRAME-LIFTING SHAFT CAP
FIG. 8
TIME OF OPERATION ½ HR.
FIG. 7-A
TIME OF OPERATION 30 MIN.
FIG. 9-A
ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED OR HEAVILY RULED. ALL JIG AND FIXTURE BODIES ARE CAST IRON. STRAPS AND FASTENINGS, MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

DETAILS OF DRILLING JIGS USED IN MACHINING THE ELEMENTS OF PRINTING-PRESS INKING MECHANISM

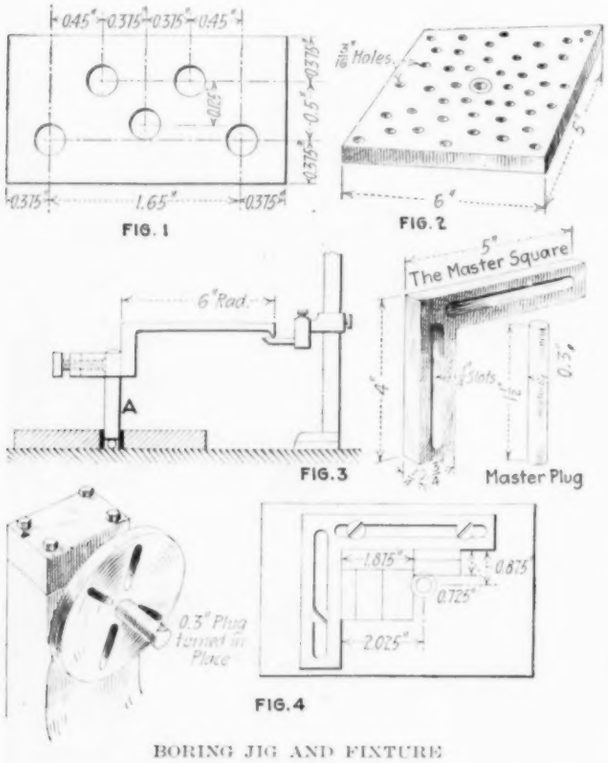
Boring Jigs and Fixtures

By J. J. McHenry

The demand for gages and precision jigs is getting more insistent every day, owing to the necessity of such tools in small- and special-tool manufacture. Some locating methods are much slower than others, and the amount of time spent on the different schemes does not always give a corresponding degree of accuracy.

As an instance, let us take a locating plate or precision jig with holes 0.250 in. in diameter and located as indicated in Fig. 1. A great majority of machinists would probably button this jig. Whether they would button all five holes before boring, or whether they would button one or two and locate the remaining buttons from plugs inserted in the finished holes, is largely a matter of choice. With a limit possibly of 0.0002 to 0.0003 in. the final completion would be doubtful.

In the first instance a great deal of time and patience would be required to set the buttons, and the location depends entirely upon the tool maker's ability with micrometers, the accuracy of the micrometers, and his patience in checking and resetting until convinced of their



BORING JIG AND FIXTURE

proper location. When it comes to setting up the work in the lathe, we have the second chance for error—in faulty indicators and in the amount of the tool maker's patience in trying to get his indicator to zero.

Third, there are the chances of the piece shifting, possibly 0.0001 in., possibly 0.001 in., maybe more; and it is likely to be finished without checking. In any case the necessary time for checking is nonproductive but essential.

The disk and button method of locating these holes could be used, but this requires a great deal of time and added expense in making hardened and ground disks, which must be absolutely accurate. The chance for error in indicating, and the probability that the work will shift, still exist.

The best, simplest and most accurate method, which is advised in preference to the others mentioned, uses a master plate, a master square, a master plug and size blocks. With these we are equipped to bore any jig or gage and require no other special tools, as they are equally adapted for any manner of spacing.

The master plate, Fig. 2, made of cast iron, is planed, scraped square and parallel with a hardened, ground and lapped bushing.

It might be well to show the manner of trammeling from the bushing, which is necessary on precision jigs. This is shown in Fig. 3.

Insert the master plug *A* in the master plate. Assume that the greatest distances from the edges of the jig are found to be 2.025 in. on one side and 0.875 on the other, as shown in Fig. 4. Allowing half the diameter of the master plug gives 1.875 and 0.725 in.

Set in the size blocks of these dimensions and add a piece of thin paper to use as proof. Then bring the master square up against the size blocks and tighten in place. Take out the master plug and the size blocks, and set in the plate to be bored. This brings the piece in the correct location to the hardened and lapped bushing for boring. Slip the plate on the turned plug in the faceplate, and bore.

For each of the succeeding holes take the plate off the lathe, but do not move the square again. Insert the size blocks. Between the master square and the piece to be bored, test as before. After tightening to see that the paper is firmly held, slip on the lathe faceplate plug and bore each succeeding hole.

This method is fast and accurate, and work can be bored within limits of 0.0002 in. to 0.0003 in. It is equally suitable for any desired location and can be found useful in many cases of accurate machining as well as for the boring of holes.

Suggestions for All Shops

By F. D. Mair

Small spring or half-spring brass wire should always be kept in the dark and wrapped up in paper; otherwise it will soon become brittle. The reason for this has not been given, but it is a fact nevertheless.

In hardening pointed instruments made of steel, such as are used by draftsmen and machinists, the heat should be applied away from the point. As soon as the heat runs down to the point, the instrument should be instantly jabbed into a piece of soap. This treatment will result in a good hard end, and it obviates the danger of burning the steel. Common yellow bar soap is best.

If a job has been chucked and is running true when the whistle blows to quit, the tool should be withdrawn from the work. When starting up next morning, the lathe should be allowed to run a few minutes before work is again begun. Otherwise the cut will be eccentric, because the oil film in the bearings will have been forced out by the weight of the spindle and work during the night. Of course this is of moment on a fine job only.

In a well-designed boring mill fitted with a proper tool and running at right speed, the cut through a cylinder should be made in the time represented by the length multiplied by the diameter divided by ten.

Manufacturing Operations on Automobile Lamps

By Ethan Viall

SYNOPSIS—Although the making of the present-day lamps is a comparatively simple proposition, it presents a number of problems that can only be solved by actual manufacturing experience. The methods of handling the shell and door parts are especially interesting. Several unusual machines for polishing reflectors are shown.

Only a few years ago practically everything formed of thin sheet metal in the way of reflectors, lamp bodies, lamp shells, lamp doors, basins, heat bells and the like was spun over forms. Now most of this work is done much faster and better in punch presses, and the use of the spinning process is an exception. The first oil or gas lamps used on automobiles were cumbersome and complicated affairs and expensive things to make. With the passing of the large-sized oil lamps and the simplification of the gas type went much of the difficulty of manufacture, but the purely electric type used so extensively now is the least complicated of all. To be sure, a large number of the smaller sizes of oil lamps are still used for supplementary side or tail lights, but even these have been greatly simplified.

The Indiana Lamp Co., Connersville, Ind., makes automobile, carriage and boat lamps of almost every size and style, though its principal run is on the various sizes of electric automobile lamps.

The ordinary style of electric automobile lamp consists of very few metal parts. The body or shell also forms the reflector. Along with this are the door, hinges, holding brackets and a few minor parts. The shell may be of various sizes and forms, according to the use to which

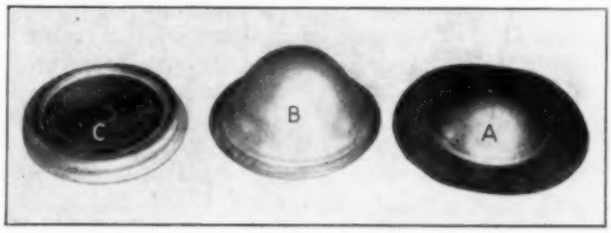


FIG. 1. DRAWN SHELL AND DOOR PARTS

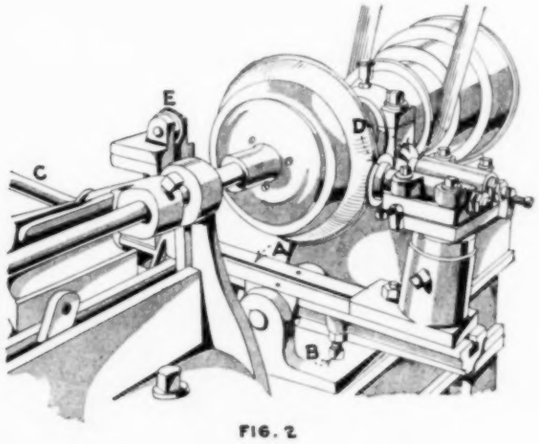


FIG. 2

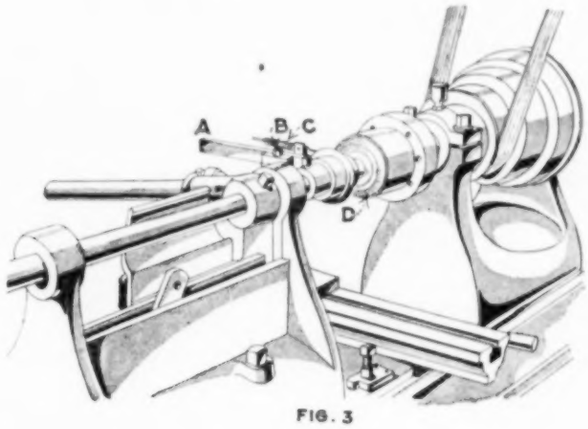


FIG. 3

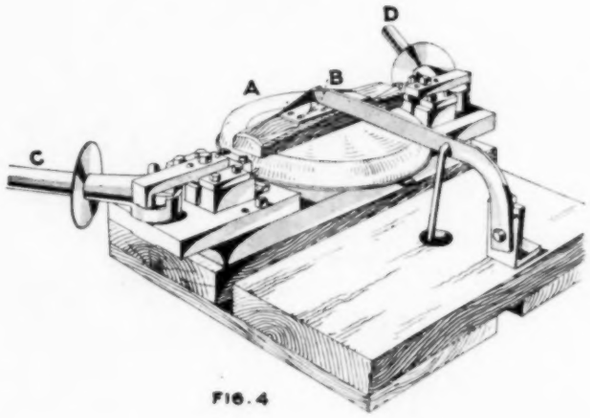


FIG. 4

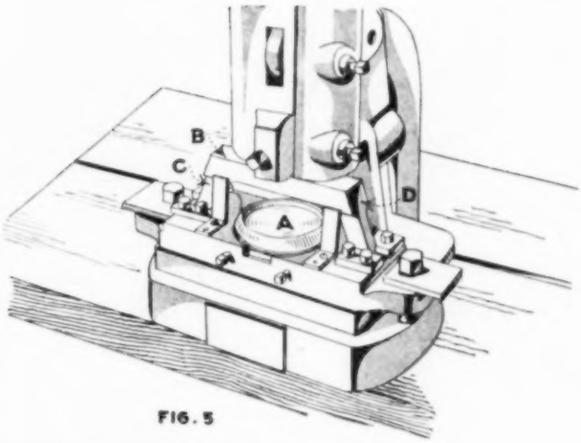


FIG. 5

FIGS. 2 TO 5. SPECIAL DEVICES FOR MANUFACTURING AUTOMOBILE LAMPS

Fig. 2—Trimming and rolling door edges. Fig. 3—Rolling in the wire groove. Fig. 4—Piercing hinge and latch rivet holes Fig. 5—Kick press fitted for piercing rivet holes

the lamp is to be put, but the type so made as to form a parabolic reflector inside is probably the more common. These shells are made in drawing dies, those made from cold-rolled steel being formed in two draws. These two draws are illustrated in Fig. 1. The pieces are for a 12-in. shell. The original blank is 16 in. in diameter and 0.036 in. thick, cold-rolled steel. The first draw is 3 in. deep and the second one 6 in. deep. At *C* is shown a door drawing. The pieces are made either from XXX tin or from No. 22 gage brass, according to the finish they are to have, and one draw is sufficient in either case. These examples may be taken as typical of the other sizes.

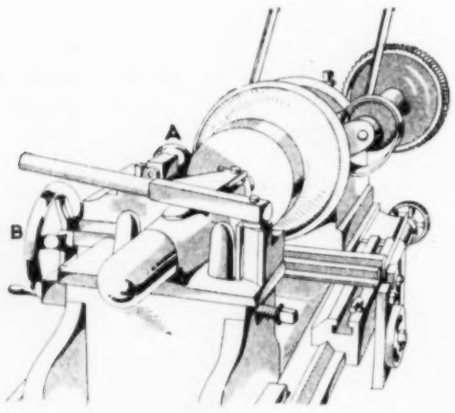


FIG. 6

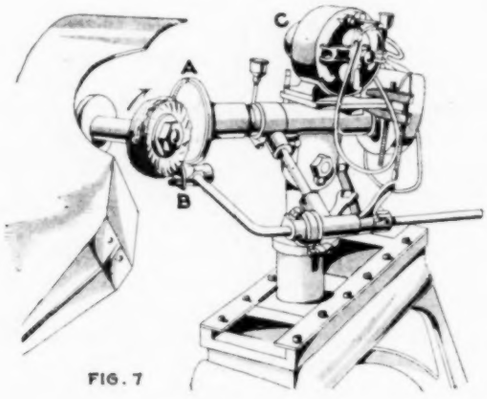


FIG. 7

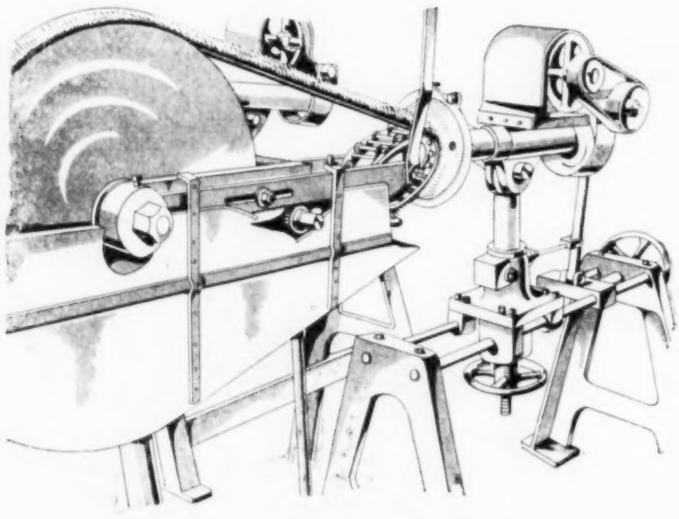


FIG. 8

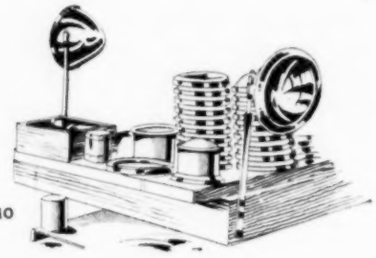


FIG. 10

FIG. 11

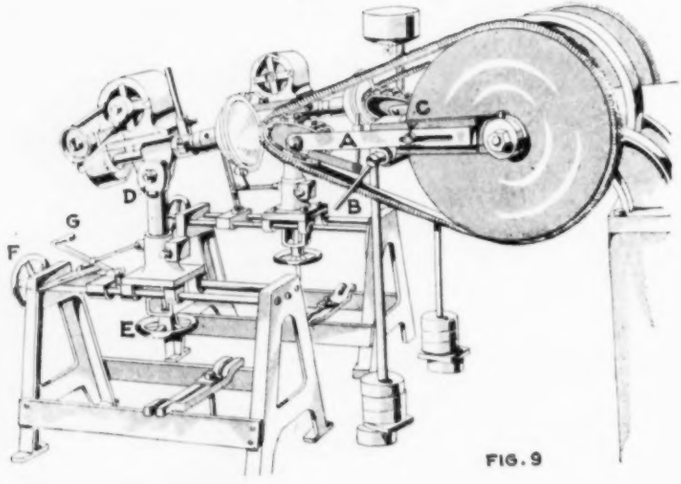


FIG. 9

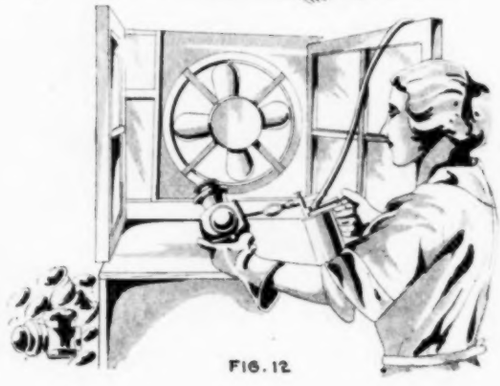


FIG. 12

FIGS. 6 TO 12. A VARIETY OF SPECIAL DEVICES USED IN MANUFACTURING AUTOMOBILE LAMPS

Fig. 6—Trimming edge of a lamp shell. Fig. 7—Simple polishing and buffing machine. Fig. 8—Belt type of automatic polishing machine. Fig. 9—A more detailed view of the belt machine. Fig. 10—Electric lamp assembling stands. Fig. 11—Riveting small lamp parts. Fig. 12—Enamel spraying outfit

the principal differences being in the depth of the draws, thickness of the metal or slight variation in shape.

The doors are formed as shown, after which a number of operations are performed on them, such as edge trimming, rolling, beading and rivet-hole piercing. Then the door is polished, and the center is blanked out. The leaving in of the center until after the polishing operation makes a stiffer piece and one in which the wheel is not so apt to catch.

The edges of the doors are trimmed and rolled in a lathe, fitted as shown in Fig. 2. The door is placed over a form screwed to the spindle nose and is held in place by means of a revolving tailstock clamp, like that used for spinning work. The trimming and rolling tools are carried on a tilting carriage *A*. This carriage has stops like *B* under each end, which may be adjusted so as to feed the

FIG. 13. AN OIL-BURNING LAMP AND PARTS

tools in just the right amount for the job in hand. By pressing down on the handle *C* the trimming rolls *D* are fed on to the edge of the door and trim it off even all around, leaving just enough to curl right when the roll *E* is pressed on to the work by lifting on the handle *C*. This method forms a much quicker way of using the tools than is possible when they are mounted on a slide.

After the edge has been trimmed and curled over, a groove is rolled in to hold the wire by which the glass is retained. This work is done as shown in Fig. 3. Here the piece is held in a way similar to that in the previous operation. The groove is put in by means of a small roller carried on the front end of the tool *A*. This tool is made to turn on the screw *B*, so that the roll may be swung to or from the work. When in working position, it is held in place by means of the latch *C*. With the roll in working position the carriage is tilted toward the operator and the groove formed, as shown at *D*. After this is done the latch is released, the tool swung back far enough to be out of the way and the door removed.

There are two ways employed for piercing the rivet holes for hinges and catches. One is by the use of a hand-operated device, and the other is by the use of a specially fitted kick press. The hand-operated device is shown in Fig. 4. It will take in large sizes, and various-sized centering forms may be placed in it to hold the doors. The work to be pierced is placed over the centering form, as shown at *A*, and is held securely by means of the foot-operated clamp *B*. The operator then pulls on the two levers *C* and *D*, and the punches carried in the slides are forced through the metal, dies being placed in the centering form for the purpose.

The kick press is shown in Fig. 5. The work is placed as shown at *A*. The punches are carried in slides which are forced in by the descent of the ram-yoke *B*, which carries the two angular arms *C* and *D* on the ends.

The final drawing of lamp shell leaves a narrow flange that must be trimmed off. This is done in a lathe, fitted as shown in Fig. 6. It is held in practically the same way as the doors, but the trimming tool is different. It is a round sharp-edged tool *A*, and it is fed against a steel cutting edge on the holding form, so that a shearing cut is taken all around. The tool is carried in a block on the cross-slide and is fed in by means of the handwheel *B*.

An odd proposition came up in the course of time on trimming shells of different sizes. An operator could trim 1,700 of the 11-in. shells but only about 1,100 of the 10-in. size. It seemed that the workman should trim a larger number of the smaller sizes, and several different men were tried, with practically the same results. The final conclusion was that the different shape of the two sizes made the difference in handling, as the larger size had a more conical bulge that could be easily grasped, while the smaller size was rounded and difficult to get a grip on in order to put it in or take it out of the lathe.

To give a good reflecting surface on the inside of the shells or on separate reflectors, the rough surface is first polished, then plated and finish buffed. The wheels do not differ from those usually employed for this work, nor do the polishing belts that are used in the machines, except in form. In other words the polishing work on reflectors is no different from similar work done elsewhere, except that automatic machines are used to do the work correctly and evenly.

One of the simpler forms of polishing machines used is shown in Fig. 7. It is used in connection with a regular polishing stand. The shell to be polished is placed in the cast-iron holder *A* and is kept from being brushed out by means of the adjustable stop *B*, the wheel revolving as indicated by the arrow. The shell holder revolves at about 36 turns a minute, being driven through a train of reduction gears from the motor *C*. The polishing wheel runs at about 2,500 r.p.m. The whole apparatus is mounted on a stand in such a way that it may be fed to or from the wheel. Both buffing and polishing wheels are used in connection with this device, according to the class of work being done.

A more complicated type of machine, used on parabolic reflectors, is shown in Figs. 8 and 9. Polishing, scratch brush and buffing belts are used in these machines. The belt is driven by means of a large wheel belted to a countershaft overhead. The working part of the belt runs over a cage of rollers, so made as to be adjusted to change the curve to suit the work in hand. By referring to Fig. 9, the arrangement for adjusting the belt and roller cage will be plainly seen. A rack arrangement *A*, operated by means of pinions and the lever *B*, moves the cage out or in to obtain the required tension on the belt. It is locked by means of the screw *C* in a slot in the sliding member. The roller cage itself has a screw adjustment of its own for holding it in any required position. The work head is driven by a small motor belted to a worm and worm gear on the work shaft. The whole head is carried on a bracket hinged to the column at *D* so as to be tilted at any angle. The column may be elevated as

required, by the handwheel *E*. The entire head and column mechanism may also be run in or out by means of handwheel *F*. A special link motion operated by the hand lever *G* makes it possible to run the work in or out quickly after the head has once been properly set.

Some of the shells are held on stands by means of their mounting brackets, as shown in Fig. 10, while the parts are being placed in them. The illustration represents the final assembly of this type of lamp.

On parts of various lamps that need to be riveted, hand work is employed exclusively. As a rule only a stroke or two of a hammer is needed in any case to fasten the parts securely together. Special anvils are used to give an easy hold for riveting. In most cases these anvils have a cupped-out place for the rivet head. One of the outfits is shown in Fig. 11.

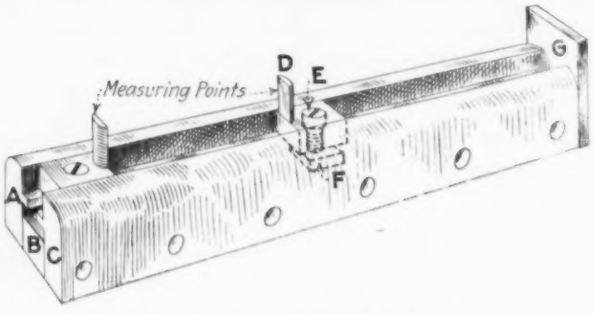
Many small-sized oil-burning tail lights are made. They are manufactured on a sort of unit system, and are so planned as to be easily put together separately and then assembled. In order to give an idea of the method, a complete and a disassembled lamp are shown in Fig. 13.

Lacquering or enameling, where this finish is required, is done as shown in Fig. 12. A De Vilbiss vaporizer is used, and the work is done inside a hood at the back of which is placed a fan to carry off all the fumes, or vapors.

Convenient Adjustable Gage

By D. Baker

The device shown is handy for the tool and gage maker's kit. It was first designed as a ready means of measuring small snap gages without the necessity of turning up plugs for each one, but it has since been found to be very useful in many other ways, taking the place of,



A CONVENIENT ADJUSTABLE GAGE

and being more rigid and accurate than, the vernier, on account of its shorter measuring points.

The three pieces *A*, *B* and *C* are riveted to form the body of the tool. They are hardened and ground all over. *D* is one of the hardened, ground and lapped measuring points which slide in the groove in the body of the tool. It is held in position by the screw *E* and the nut *F*.

To use the tool, the points are adjusted to the work in about the same manner as with an ordinary caliper; that is, by tapping the points until the proper "feel" is obtained, when with the screws tight, an ordinary inside or outside micrometer is used to find the exact measurement.

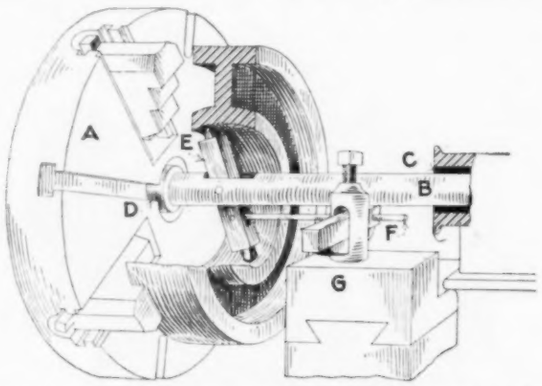
On the end will be noticed a piece *G*. This is also hardened, ground and lapped and will allow measurements being taken close up to the end of the tool as frequently is necessary on account of a shoulder or other projection on a piece of work.

One advantage of this tool is that more than one form of point can be made up and used with it as the work may require.

Spherical Boring on a Lathe

By W. C. Makley

In the illustration is shown a handwheel the bore of which is to be machined out spherically. The work is done on a turret lathe with power cross-slide. The piece is held in the scroll chuck *A* mounted on the turret-lathe spindle. The bar *B* is held in a bushing *C* inserted in the



SPHERICAL BORING ON HORIZONTAL TURRET LATHE

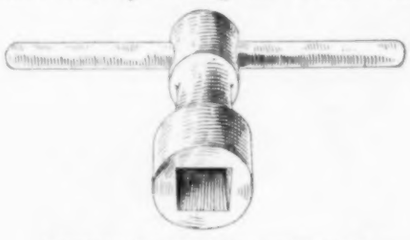
turret and in a bushing *D* mounted on the spindle. This bar is slotted at one end to permit the part *E*, which is pivoted at its center to the bar, to oscillate back and forth in a direction parallel with the center line of the bar. Two boring tools are inserted in the ends of *E* and held by a setscrew. A small rod *F* is fastened to the part *E* at one end, and to the cross-slide *G* at the other end, there being sufficient clearance between the work and the bar to permit the rod to pass through.

In order to bore the center of the work spherically, the cross-slide is moved along the bed by hand or power, while the work is revolved, causing the part *E* to oscillate about its center, where it is pivoted to the bar, thus causing the boring tools to move in the arc of a circle and generate the required form in the work

Improved Type of Wrench

By J. H. Davis

When a chuck is being used on the lathe, it takes quite a few seconds to enter the chuck key in the square hole. I have found that by making the wrench as shown in



IMPROVED TYPE OF WRENCH

the illustration, with the handle going across the square, the key may be inserted more quickly. As usually supplied, the handle goes across the corners of the square.

Making Adapters for British Detonating Fuse

By Fred H. Colvin

SYNOPSIS—A comparatively simple job and yet one which requires splitting into several operations to increase production and secure accurate work. Here again the threading is done in separate operations, although hard threading is avoided in this instance.

The adapter, shown in Fig. 1, is used in connection with the British detonating Mark-100 fuse, as illustrated on page 749, Vol. 43. It is made of machine steel $1\frac{11}{16}$ in.

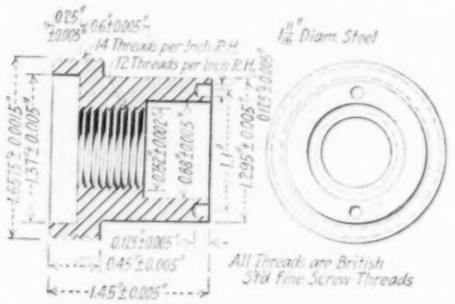


FIG. 1. ADAPTER FOR BRITISH NO. 100 DETONATING FUSE USED ON VARIOUS SHELLS

in diameter and screwed inside the fuse body, making a connection for the gaine, which is screwed inside the adapter.

These pieces are made from bar stock on National Acme automatics No. 56, the first operation being shown in Fig. 2. The adapter blanks then go to the Cleveland automatic, shown in Fig. 3, utilizing the tilting magazine for this purpose. This machine simply counterbores the large end, as shown in Fig. 4.

The chip-draining pans, shown in Fig. 5, are used in connection with both the first and second operations and are found to be very convenient for any work of this kind. They are simply large, widely flared funnels with the lower end somewhat smaller than the top of an ordinary galvanized-iron bucket. They are placed near the machine, and the chips are shoveled into them from the machine pan. They allow a larger proportion of the oil to drain into the bucket, making it immediately available for further use. The chips then go to a centrifugal separator, where the remainder of the oil is extracted. Although these funnels are generally used singly, they are occasionally stacked up as shown, to save floor space.

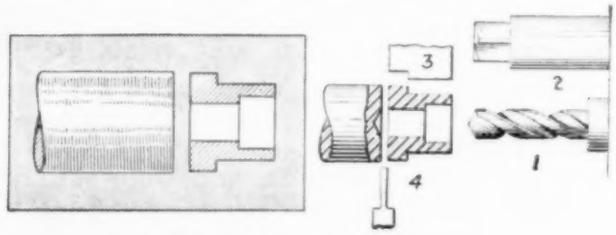


FIG. 2. THE FIRST OPERATION

Machine Used—National Acme No. 56.
Special Fixture—None.
Gages—See Fig. 10.
Production—60 per hour per machine.

The adapters are now ready for threading, none of this being done on either of the automatics. The third operation is the tapping of the thread for receiving the gaine,

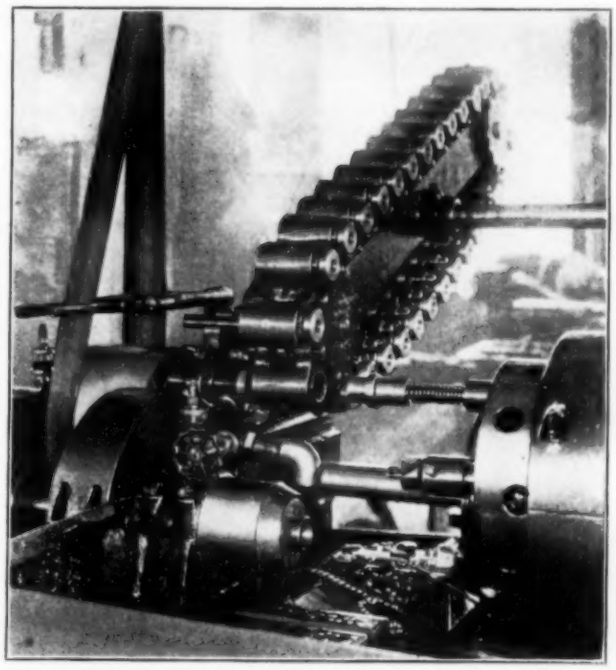


FIG. 3. SECOND OPERATION ON CLEVELAND AUTOMATIC

this being done in almost any kind of lathe, although a hand turret is preferable. A tapper tap is held in a suitable chuck on the lathe spindle, and the adapter is held in the turret while it is being fed over the tap. When the shank of the tapper tap is full, it is removed from the chuck, the pieces are slid off and the operation is repeated. It is illustrated in Fig. 6.

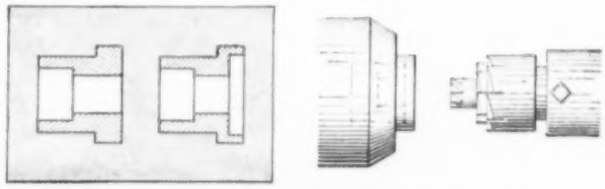


FIG. 4. SECOND OPERATION—COUNTERBORING

Machine Used—Cleveland automatic.
Special Fixture—Tilting magazine.
Gages—See Fig. 10.
Production—90 per hour per machine.

The next operation is cutting the threads on the outside of the adapter, this also being done in a plain turret. The work is held in a spring chuck, and a self-opening die is used for the threading. Dies of the Geometric, Modern, and Warner & Swasey types are all used for this work.

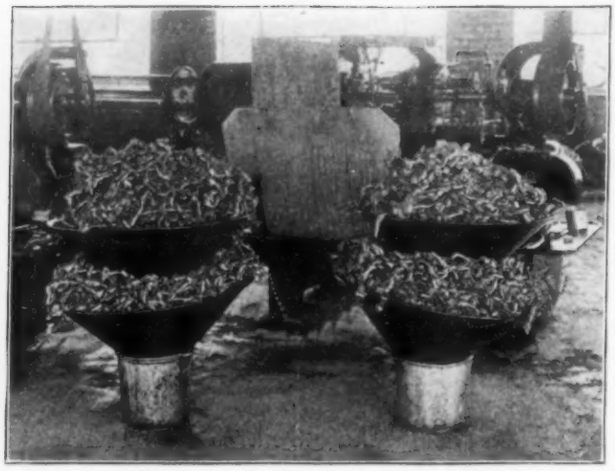


FIG. 5. FUNNELS FOR DRAINING OIL FROM CHIPS PRIOR TO CENTRIFUGAL SEPARATION

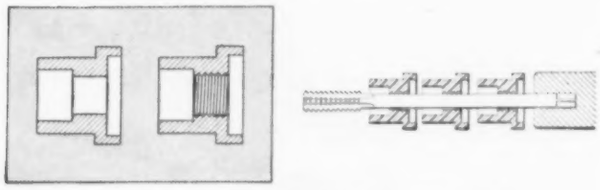


FIG. 6. THE THIRD OPERATION—TAPPING

Machine Used—Hand turret, Smur & Kammen.
Special Fixtures—Chuck-in turret and tapper tap.
Gages—See Fig. 10.
Production—150 per hour per machine.

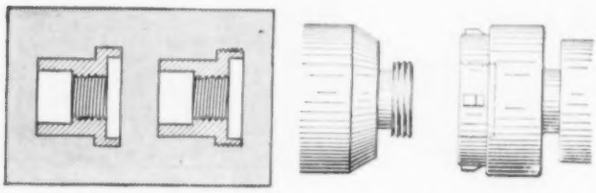


FIG. 7. THE FOURTH OPERATION—THREADING

Machine used—Hand turret.
Special Fixture—Self-opening die head.
Gages—See Fig. 10.
Production—300 per hour per machine.

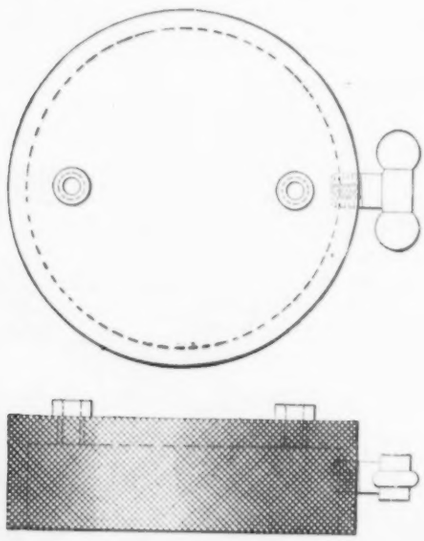


FIG. 9. SIMPLE DRILL JIG ESPECIALLY DESIGNED FOR ADAPTER WORK

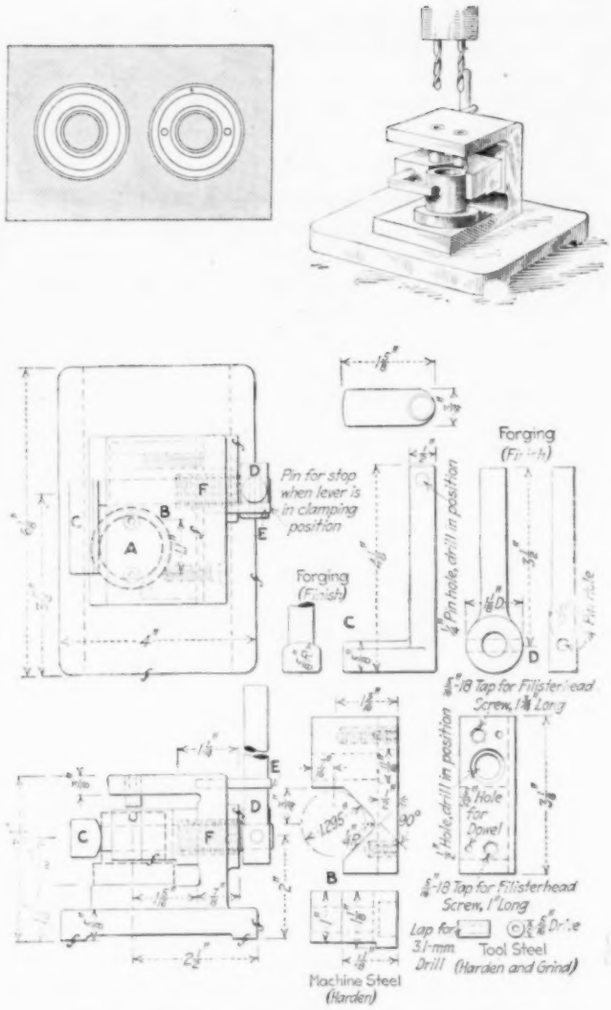

Pin for stop when lever is in clamping position
Forging (Finish)
Pin hole, drill in position
Hole, drill in position
Hole for Dowel
Machine Steel (Harden)
Tool Steel (Harden and Grind)

FIG. 8. THE FIFTH OPERATION—DRILLING

Machine Used—Leland-Gifford drilling machine.
Special Fixtures—Sellew two-spindle drilling head.
Gages—See Fig. 10.
Production—400 per hour per machine.

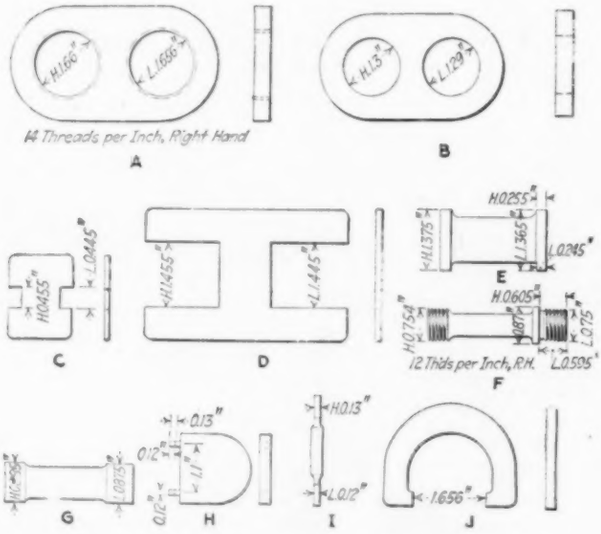


FIG. 10. GAGES USED FOR THE ADAPTERS

A—Diameter of outside screw thread. B—Diameter of plain part. C—Length of screw. D—Total length. E—Diameter and depth of recess at top. F—Diameter and length of internal thread. G—Diameter of small bore. H—Depth and distance of keyholes. I—Diameter of keyholes. J—Low or "not go" diameter of screw threads.

A fifth and last operation is drilling the two holes for the side spanner wrench, as shown in Fig. 8. This is done in a simple drilling jig. The adapter *A* fits into the block *B* and is held in place by the hook bolt *C*, which has a rounded surface on the inside of the hook and a pin handle *D* at the other end. It is held closed by the spring *F*. This hook bolt is swung to an angle of about 90 deg. to release and to lock the adapter. The pin *E* affords a stop for the handle *D* when in a locked position.

A two-spindle Sellew drilling head has been used on a Leland-Gifford high-speed drilling machine.

Fig. 9 shows a very simple type of jig for this work. It has been used by another contractor making adapters.

The gages used are shown in Fig. 10.

Increasing the Usefulness of a Radial Drilling Machine

By R. W. Grace

The standard pattern of radial drilling machine is equipped with a drill table having three or four slots and large enough for one job at a time. By providing a second table at right angles to the standard table a considerable increase may be made in the output.

In a machine shop drilling automobile cylinders this arrangement was possible, as two jigs were used, one for each table.

When one table with casting and jig is ready for setting the second table is loaded with part and jig, as before. The drill hand has by this time completed the drilling of the first casting. The machine arm is then swung around to the second table, where the jig is all ready. This method of handling the work makes it almost continuous.

Drilling Long, Small Holes

By A. R. Robertson

Not infrequently it becomes necessary to drill in steel small holes of considerable length; that is, holes as small as a No. 30 drill and from 4 to 6 in. in length. In work of this kind the drill clogs, breaks or does not run straight, resulting in spoiled work. I have found a way to overcome this difficulty.

The drill should be ground so that one cutting lip is slightly longer than the other. This, of course, will produce a hole slightly larger than the diameter of the drill, but by selecting a somewhat smaller drill the hole can be made fairly close to the desired size. The action of this drill seems to be to break up the chips and prevent the drill from sticking.

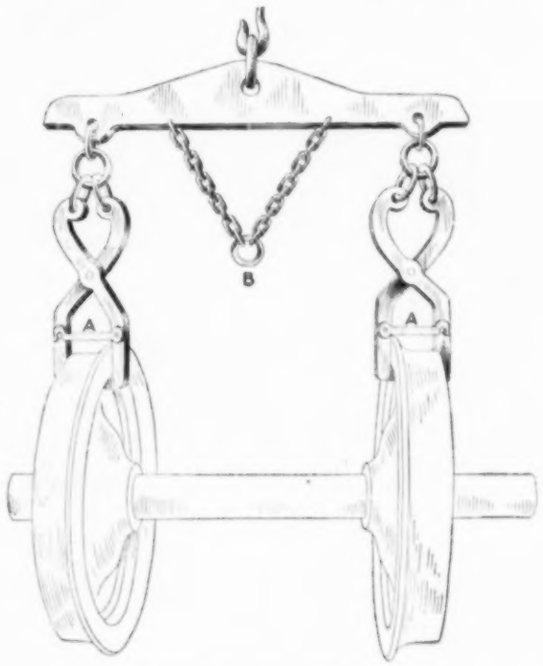
In holes of these small diameters only about ⅛ in. can be drilled before withdrawing the drill for cleaning and oiling. A great deal depends upon getting the drill started true, and it will be found advantageous to start the hole with a short tool, the work being revolved in a chuck. It is well to have the small drill fitted nicely into a tube that can be made quite stout. The drill shifts forward in the tube as the hole deepens, being held by a setscrew in the tube.

If these suggestions are followed, quite satisfactory results can be obtained, but the work is slow, requiring about 25 min. to drill 6 in. in soft steel. A great deal of care must be taken to get the oil into the hole during the operation of drilling, and pure lard oil thinned with kerosene is about the best lubricant to use. The speed should be considerably higher than is usually employed by machinists, and the feed should be very delicate and sensitive.

Car-Wheel Lifting Device

By J. A. Lucas

The illustration shows a wheel-lifting clamp that has been devised especially to handle wheels having a plate or web in the center. Most of the lifting clamps illustrated depend on the hooks going between the spokes, which is



CAR-WHEEL LIFTING DEVICE

obviously impossible in this case. The lifter shown can be used on wheels of either kind.

In order to make this appliance doubly secure, we put the hook at *A* to prevent the possibility of the hooks dropping the load under any conditions. The chain *B* was added so that the lifter could handle other work.

Smoke Nuisance Investigation

A recent investigation of the smoke nuisance in Chicago, under the able guidance of Dean Goss of the College of Engineering, University of Illinois, shows some interesting facts. Instead of the railroads being the worst offenders, as usually supposed, they are responsible for but 22 per cent. of the visible smoke and but 7.47 per cent. of the solid particles discharged into the atmosphere.

About 65 per cent. is due to stationary steam plants for power and heat, making the manufacturing plants of various kinds the greatest offenders. This of course pleases the railroads; but as the main question is the abatement of smoke, regardless of who is responsible for it, there is no room for self-congratulation in any quarter. Citizens have a right to demand that all business shall be conducted with as little nuisance as possible.

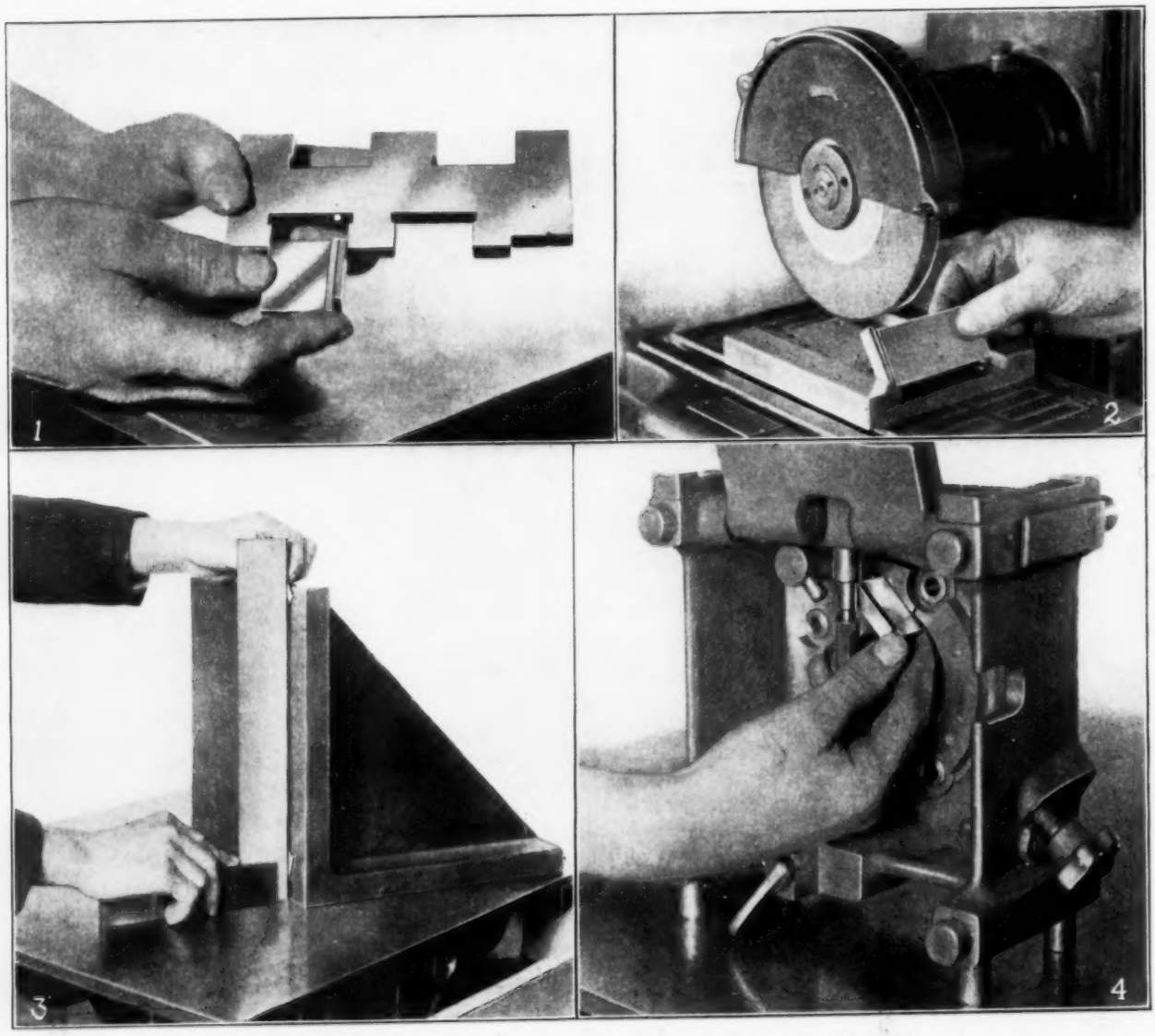
Johansson Gages in Tool Making

By Louis Ruthenburg*

SYNOPSIS—New tools bring new methods. Several of those developed in tool making to secure effective use of Johansson, or Swedish, gages have been gathered together into this article. Their use brings ease and certainty in making accurate measurements.

"One good turn deserves another." Every major invention has a following of innovations to adapt it to its various fields of usefulness. Likewise, new machines bring novel processes, and new tools bring new methods. The most recent aid in doing work in the machine-shop toolroom. It is therefore but natural that, as these gages came into use, methods were brought out or discovered to gain the greatest possible benefit from their accuracy and ease of application. A few of these applications that are now used daily have been gathered together into this article.

As a rule, all such set-ups, or methods, are simple and need only to be shown to a mechanic to have him see how they are done and to be able to do the same things himself. So it seems to me that only a small amount of description is needed by *American Machinist* readers, as



FIGS. 1 TO 4. APPLICATIONS OF SWEDISH GAGES IN THE TOOLROOM

Fig. 1—Direct measurement of snap-gage opening. Fig. 2—Direct measurement of fixture slot. Fig. 3—Measuring accuracy of right-angle fixture. Fig. 4—Measuring distance from pad to bushing in a jig

ingenuity, skill and effort of both inventor and user are necessary to get the most and best out of any departure from the usual, whether it be a device or a discovery. Only a few years ago Johansson, or Swedish, gages were the the illustrations show how the Swedish gages are actually used for measuring or checking other gages, jigs and fixtures, for laying out, and for setting indicators for inspecting. The benefit that comes from using methods such as these is the greater ease and certainty with which

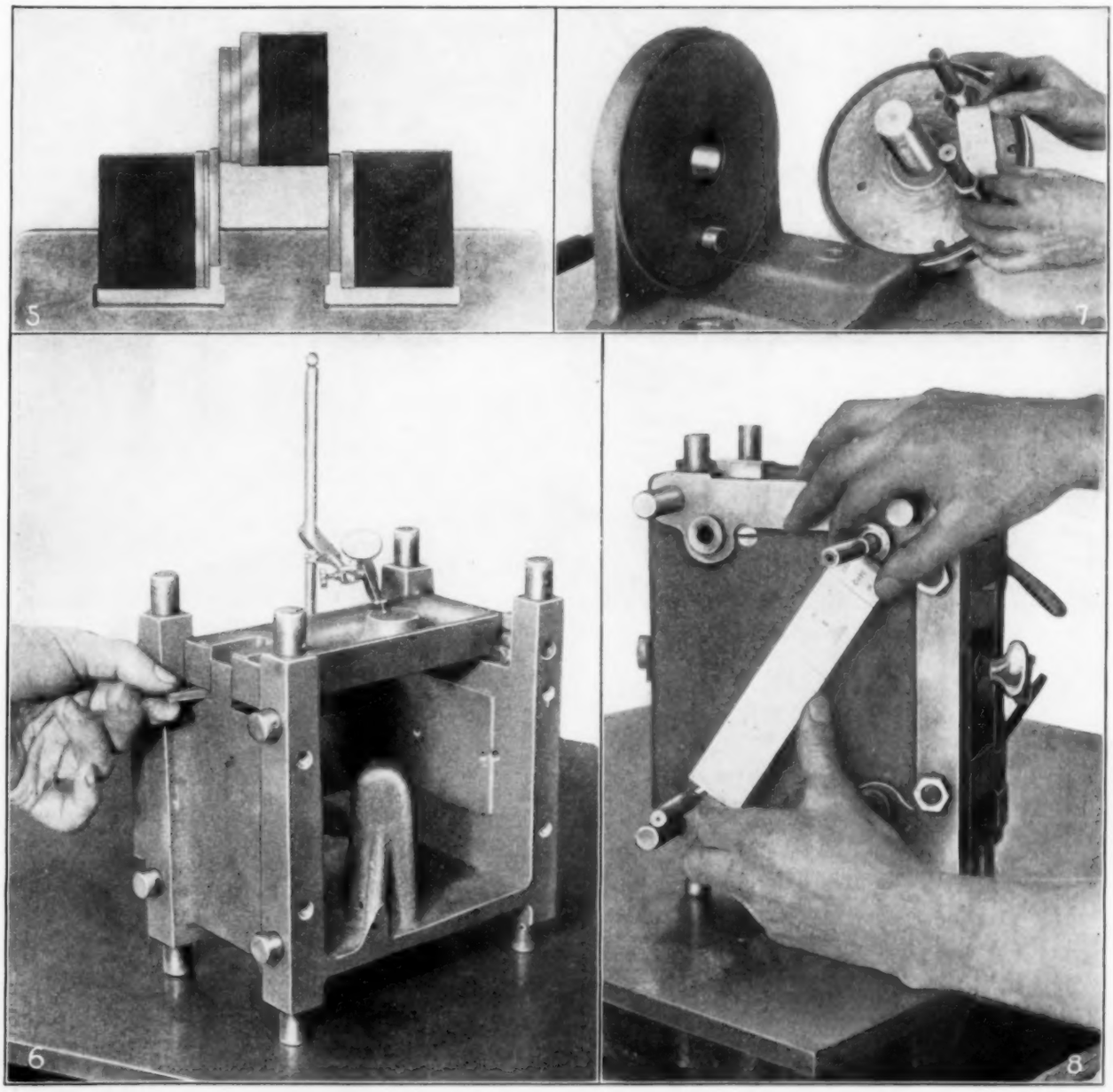
*Chief inspector, Dayton Engineering Laboratories Co.

measurements can be made. The gages should be thought of as tools to be used by the tool maker to save him time and worry, instead of as mere references to be consulted only when it is necessary to settle some dispute.

The first application that I show, in Figs. 1 and 2, saves time and secures a high degree of accuracy by the direct measurement of snap gages and fixture slots. It is hard to conceive of a simpler scheme than that of fitting together the necessary gage blocks and then trying them into the opening or slot that is to be measured.

Gages wear rapidly, particularly when used for shop inspecting on grinding and lapping operations. A difference of a few ten-thousandths between the gages used by operators and inspectors often causes disputes. Thus, facilities that aid in the making and inspecting of the gages used in production earn real dividends.

If a right-angle fixture is made so that it is out of square only 0.0001 in. at a point 6 in. above the base, the job is considered pretty accurate. The tissue and feeler tests for such a fixture, using a standard square, are familiar to every tool maker. Fig. 3 shows how to measure—not merely test—an angle plate under such conditions. The one shown happened to be a little wide at the top. A Johansson block, size 0.1001 in., was held against the bottom of the angle plate by the square. The next largest block in the case, size 0.1002 in., was then tried at the top of the plate. As both gage blocks were held in place with the same amount of pressure, there was obviously a difference in dimensions between top and bottom equal to the difference in the sizes of the two blocks. In the case shown, this difference was 0.0001 in., which was readily eliminated.

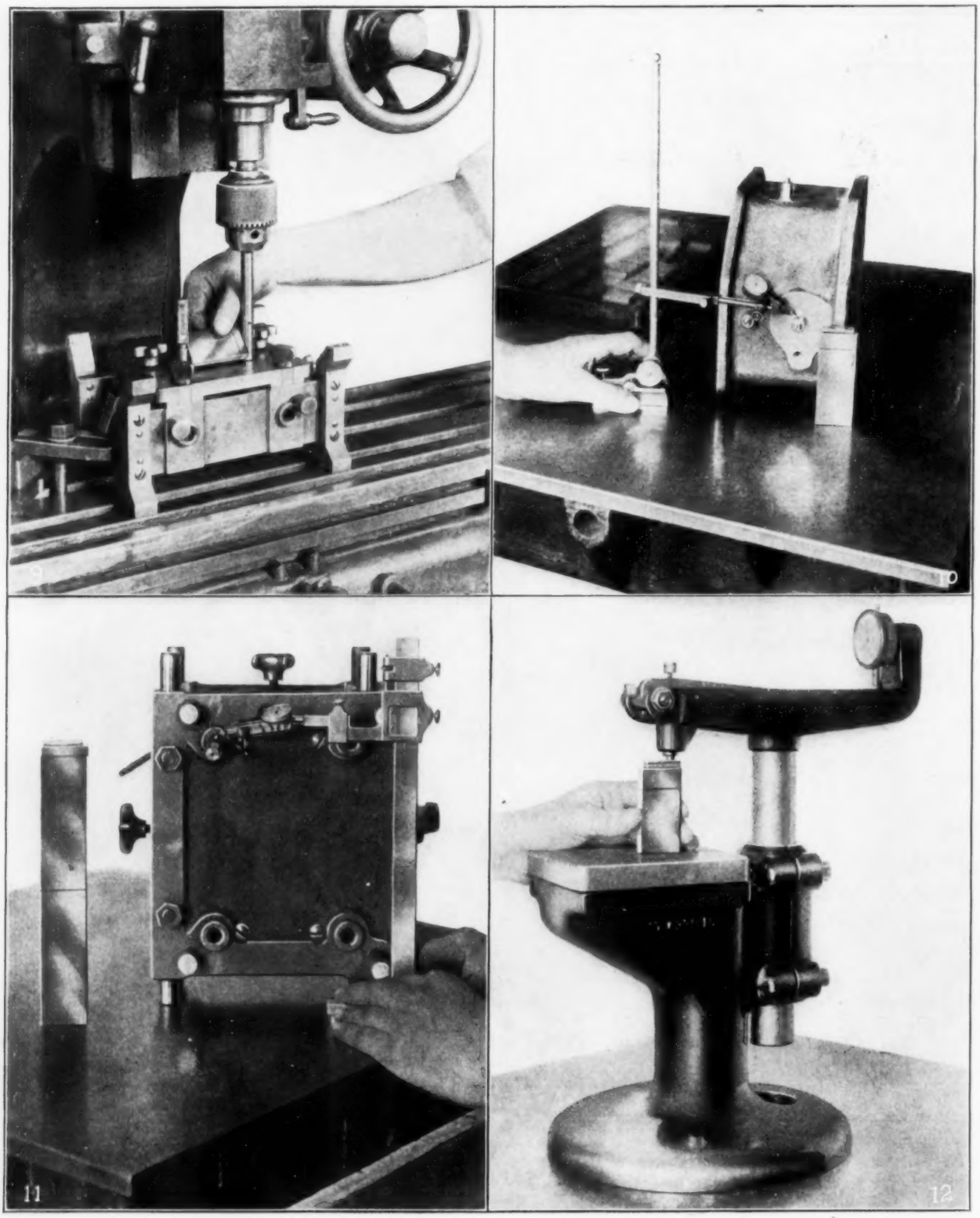


FIGS. 5 TO 8. OTHER APPLICATIONS OF THE JOHANSSON SWEDISH GAGES

Fig. 5—Measuring distance between gage openings. Fig. 6—Determining thickness for a striking block. Fig. 7—Spacing holes in an indexing fixture. Fig. 8—Spacing holes in a drilling jig

The most common cause of head-scratching in the toolroom is a job having points between which accurate measurements must be made, but which are so situated that they are difficult of access. This condition often causes the mechanic to use inaccurate, makeshift methods. A job of this kind is shown in Fig. 4, where it was necessary to measure in the drill jig from the rest pad to the bushing. The method illustrated is wonderfully simple, quick and accurate.

Fig. 1 shows how to measure the opening in a snap gage. The adaptability of the Johansson system of gaging to the problem of measuring the distance between two



FIGS. 9 TO 12. APPLYING THE SWEDISH GAGES TO LOCATING AND GAGE-SETTING WORK

Fig. 9—Locating boring bar from a bored hole. Fig. 10—A simple method for setting buttons. Fig. 11—A simple method for inspecting jigs. Fig. 12—Setting a dial indicator for inspecting

slots—in Fig. 5 the distance between the two gage openings—gives another idea of its usefulness among the varied requirements of tool making and inspecting. The illustration is self-explanatory. Incidentally, not only is an accurate measurement made of the distance between the openings, but the parallelism of the slots, both vertically and horizontally, can also be noted accurately.

When box jigs must be so designed that they will maintain their accuracy, they are usually fitted with striking blocks between the lid and the frame. The time-consuming, comparatively inaccurate method of cut-and-try is the one usually employed for fitting these blocks. Fig. 6 shows something vastly different. Swedish gage blocks are slipped under the lid. When the correct combination is found, the indicator shows parallelism between lid and base. The combined thickness of the gage blocks is then noted and the striking blocks ground to correspond.

A job that taxes the skill of the most painstaking mechanic is the proper spacing of holes in highly accurate indexing fixtures. On work of this kind, disputes sometimes arise between the tool maker and the tool inspector about "the way the vernier was read." A simplified method that is beyond dispute is illustrated in Fig. 7. Swedish gages built up to the proper length feel between standard plugs in the holes, whose spacing must be accurate.

This same method is applied equally well to the measurement of hole spacing in drill jigs, Fig. 8, and in locating work for boring, Fig. 9. In the latter view a transfer bar held in the miller chuck is the starting point for the measurement. From this the dimension is checked with reference to a standard plug in a hole. A similar measurement might be made to some reference surface on the work.

In many tool rooms the setting of buttons for locating boring operations is a slow, tedious process. At the same time it is a method that frequently provokes much profanity, especially when a finished tool is rejected because someone slipped in reading his height gage. When you substitute Johansson's gage blocks for the usual measuring tools, the method of setting buttons simplifies to the following:

A combination of blocks is selected, corresponding to the distance from the bottom of the jig to the top of the button. This dimension is the distance given on the drawing to the center of the hole to be bored, plus one-half the button diameter. Now set up the jig and blocks on the surface plate and adjust the indicator to read zero when it is drawn across the top of the stack of gage blocks. The indicator is then moved to button No. 1, which is adjusted until the pointer registers zero. Without disturbing the original combination of the gage blocks, select a second combination corresponding to the location of button No. 1 from the side of the jig. Turn the jig over on its side and adjust the button in this second direction. This finishes the location of button No. 1.

Now leave the top block of the original combination projecting slightly over its mate, add other blocks as needed and proceed to locate button No. 2 in the same manner. If two buttons are so located, we will have two stacks of gage blocks, each having a projecting block to indicate the location of one button, while the tops of the stacks indicate the location of the second. It is now a very easy job to check all dimensions in "jig time."

This method and the underlying principle are shown in Fig. 10, where the first step is set up. A simple jig was selected for this example and only a few blocks stacked in combination, to avoid any possible confusion in understanding it.

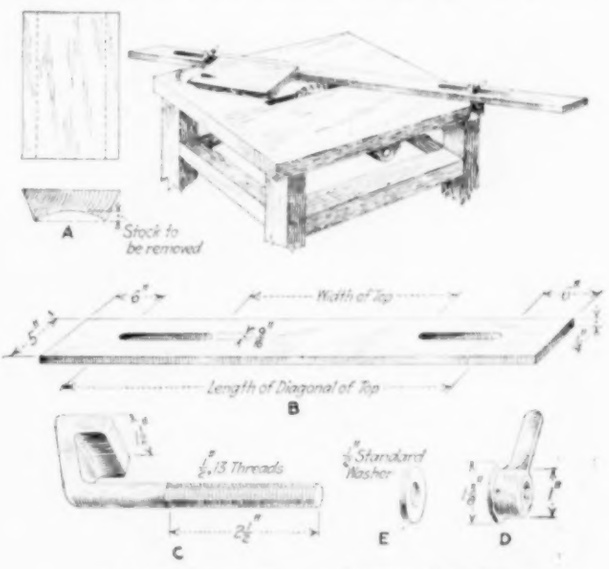
Of course, the same process is applied by the inspector in checking the jig when finished. Fig. 11 shows this operation. The height gage that appears in this view is used only as a convenient means for holding and adjusting the dial indicator, which feels the top of the standard plug and the top of the stack of gage blocks.

The highly sensitive indicating gage is coming into more and more use for inspecting, because of the time it saves and the means it provides for obtaining accuracy in production. It is a tool that lends itself to fast, accurate results in gaging a wide variety of work. Such a gage is shown in Fig. 12. Each graduation of the dial is equivalent to a variation of 0.0001 in. in the work. The illustration was prepared to show the method of using Swedish gage blocks to adjust the dial zero at the middle of the tolerance range of the work to be inspected. For example, let us suppose that the work to be gaged is a ½-in. straight-ground shaft with limits of 0.4995 and 0.5005 in. The dimension midway of these limits is 0.5000 in. A gage block of this size is used to adjust the dial to read zero. All work that is within the limits set will not move the indicator pointer more than five graduations either side of the zero point.

Cutting Lags To Fit Around a Curved Surface

By S. L. Cook

The device described, while not intended to revolutionize pattern-shop practice, will be found to be extremely handy, and in a shop where there is a great deal of "lagging up" or stave work it will prove almost indispensable, as it will quickly take the place of the usual straight-edge and hand screws.



ATTACHMENT FOR A CIRCULAR SAW

At *A* is shown an assembly of the rig on the saw table. On some saw tables it will be necessary to remove the fence, but this operation requires but a very few seconds.

The straight-edge shown at *B* should be made of maple planed on both sides and carefully straightened on

both edges. There should be a small hole bored near one end about ½ in. in diameter, to hang the rig up by when not in use.

The hook and the wing-nut, shown at *C* and *D*, are given in detail, and no difficulty will be experienced in making these two patterns. The castings should be made of bronze, and what little machine work is required may be easily done with the pattern-shop drill press and a hand tap and die borrowed from the machine shop. Two castings of each are required.

The standard ½-in. washer, shown at *E*, will be easily found. Obtain two ½-in. washers. The use of this device will be apparent to any pattern maker. If a little time is spent in constructing it, the saving will easily pay for it many times over. It will add to the efficiency of the pattern makers' old standby, the circular saw.

Indexing Work Tables for the Drilling Machine

Two indexing work tables that are extremely handy for various shop jobs, or for holding jigs and fixtures, are shown in Fig. 1. They are made by the Mueller Machine Tool Co., Cincinnati, Ohio, and all the radial drilling machines in its shop are equipped with them.

The slotted tables, 16x26 in., are 3½ in. thick. The circular part is 18 in. in diameter. Most of the tables are bushed quartering for the index pin *A*, but as many holes can be made and bushed as the conditions require.

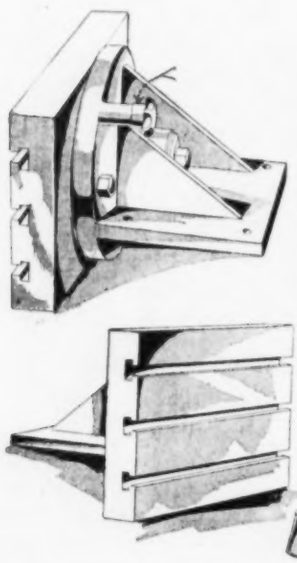


FIG. 1. INDEXING WORK TABLES

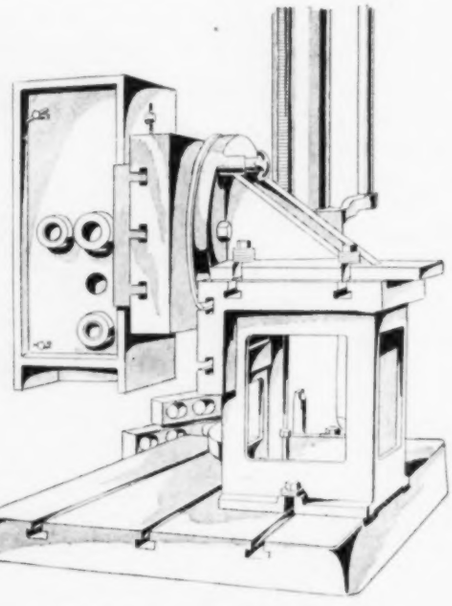


FIG. 2. APRON JIG BOLTED TO TABLE

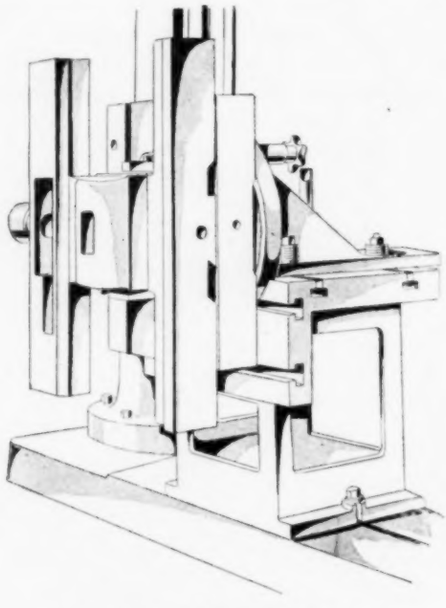


FIG. 3. LATHE SADDLE IN PLACE

The feature of this type of table is that a jig may be bolted to it; by using a radial drilling machine, all the holes may be drilled in the piece before removal and with the minimum labor on the part of the operator.

Fig. 2 shows one of these tables with a lathe-apron drilling jig bolted to it. Fig. 3 shows a similar table with a lathe saddle clamped to it. The size of the tables makes them strong and rigid enough for any ordinary shop use. Besides the heavy center pin on which they revolve, there are two heavy locking bolts, working in a circular slot, to clamp the table solid after locating.

Annual Manganese Production

The manganese ore and metal industries continue to undergo readjustment, but the impetus given the domestic industry on account of the shortage of foreign ore has not brought forth the production that had been expected. Important exploratory work and preparations for milling have been carried out at several mines in Virginia, Tennessee, Colorado and California, but except in the case of one mine this has not yet resulted in production. A close estimate of the production in the United States for 1915 cannot be made, but it is very doubtful that it exceeded 6,000 tons, as compared with 2,635 tons produced in 1914, according to the United States Geological Survey.

The shortage in high-grade ores for use in the manufacture of flint glass and dry batteries has been keenly felt, and several dry-battery plants have been forced to close down.

The shortage of imports forced two important steel producers—Jones & Laughlin Steel Co., of Pittsburgh, Penn., and Maryland Steel Co., Sparrows Point, Md.—to devote furnaces to the manufacture of ferromanganese. This is noteworthy because most of the domestic ferromanganese has heretofore been made by two subsidiaries of the United States Steel Corporation, although several more firms have occasionally contributed.

Efforts are being made to conserve during refining the manganese contained in raw pig iron, thereby reducing the amount of ferromanganese that must be added to make steel. If these efforts are successful, they will mark an important advance in steel metallurgy.

During the first 10 months of 1915 Brazil supplied a very large proportion of the manganese oxide and ore that was imported into this country. The total from the South American country was more than twice the average for the preceding three years and partly made up for the failure of supplies from Russia and India. The receipts from India were about one-twelfth normal and from Russia negligible.

Tools Used in Machining Small Connecting-Rods

By E. P. Gleason*

SYNOPSIS—In this article are described the tools used when machining connecting-rods used on a motor-operated boat. The forging is straddle-milled for the first operation, and in the next operation the larger end is rough and finish bored. A locating plug is then used to center the rod for the subsequent operations. A neat open-side latch, which is tightened against a turned shoulder on the locating rod, is noteworthy.

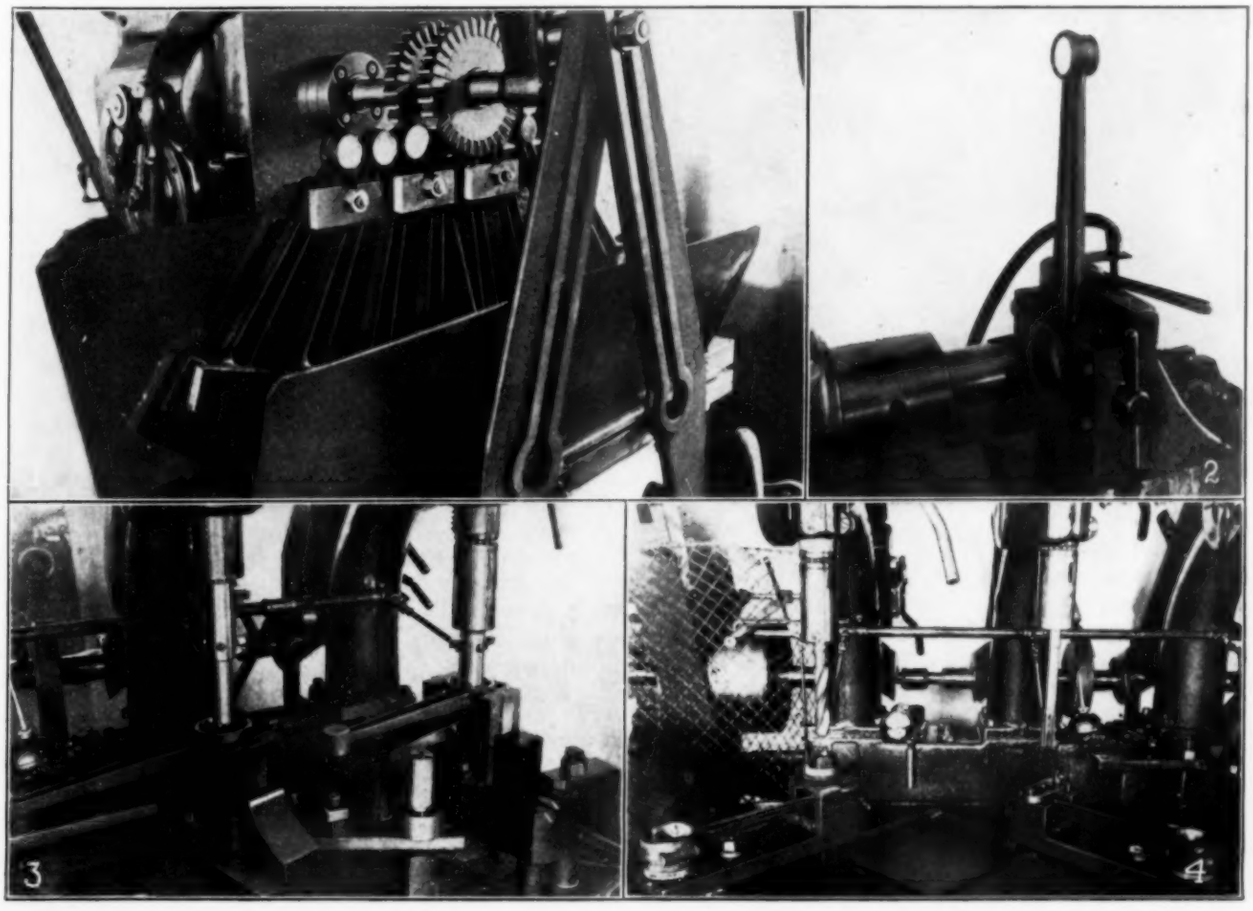
The operations observed when machining a small connecting-rod are of interest, and here are shown the tools and methods used, also the times and productions for each operation.

Operation 1 is straddle-milling the small end or piston-pin end. Eight rods are machined at one setting, clamped at each end in the usual manner and lined up by the face of the large end and the web at the small end. This operation could be improved upon by lining up the small end by the clamp screw lug against a V-block, as in operations 2 and 3. The machine output for one man in 10 hr. is 600 rods. The set-up is shown in Fig. 1.

Operation 2 refers to rough-boring the large, or crank-pin, end. This operation is done on two lathes which are tooled up by turning up a tool holder for a lathe spindle and inserting a high-speed cutter, as shown. The rod is lined up by V-slots clamping onto the bolt lugs and is securely held by the clamp. This method insures alignment and evens up the stock around the edges of the bolt holes.

One man puts out 500 per 10-hr. day on two lathes, removing ¾ in. of steel at the center of the forging. The method of tooling is shown in Fig. 2.

Operation 3 is finish-boring the large end. The jigs are made from two jaw chucks with V-jaws, as shown, thus following the same lining up as in operation 2. The cutter bar is piloted by a bushing bolted between the jaws to the face of the chuck. Two tools are used for boring and one for facing. The facing of the side is gaged by measuring from the center of the V-blocks. One man puts out 250 per 10-hr. day on two jigs. The manner in which this operation is performed is shown in Fig. 3.



FIGS. 1 TO 4. MILLING AND BORING TOOLS FOR CONNECTING-ROD ENDS

Fig. 1—Straddle-milling the rods. Fig. 2—Rough-boring large end. Fig. 3—Finish-boring large end. Fig. 4—Drilling and reaming small end

*Superintendent, Evinrude Motor Co., Milwaukee, Wis.

Operations 4 and 5 refer to drilling and reaming the piston-pin hole in the small end. The rod is fastened with the faced side down, bringing both holes at right angles with the web and parallel with it.

In placing the rod in the jig the small end is centered by a V-slot in a crosshead held by spring tension at the back. The large end is supported on the bottom by an adjustable pilot perfectly fitting the large end. When in place, a bushing is screwed down onto the rod to hold it during the operation. The reaming operation may be easily followed. One man puts out 300 per day for the two operations.

Operation 6, facing the opposite sides of the large end, is done on the drill press with a facing mill. The output for one man is 1,000 per day.

Operations 7 and 8, broaching both ends, give an output for one man of 300 per day.

Operation 9 is drilling the two holes in the bolt lugs. A four-spindle auxiliary head is fitted to a 20-in. power-feed drill press. The jig is made to hold two rods. It is held at the drilled end by washers, by eccentric clamps at the lower end and is supported by a pin. One man runs two spindles, with an output of 300 rods per day. The jig as used is shown in Fig. 5.

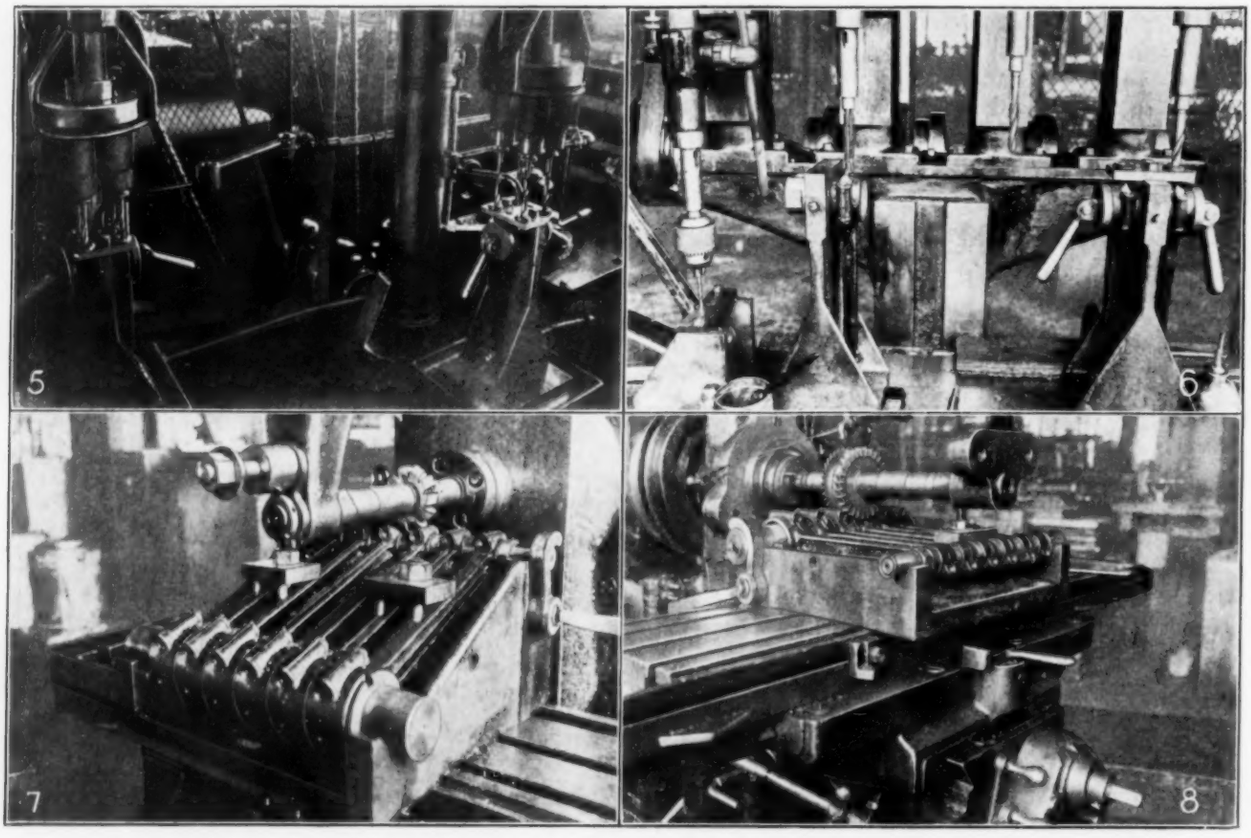
Operations 10 and 11, drilling, tapping and facing the clamp screws at the small end, are performed by one man on a three-spindle press and tapping machine. He completes 300 per day.

Operations 12 and 13 refer to drilling and reaming the pilot hole for the bushing and drilling the oil holes. The jig for drilling the oil hole is simple. A pin that fits into the reamed hole is fastened in the center of the shaft at right angles with the end terminating directly under the drill bushing. In operation the rod is held up against the bushing, as shown, until drilled on one side, then released. The rod is turned over, and the operation is performed on the opposite side. One man completes 300 per day. The jig as used is shown in Fig. 6.

Operations 14 and 15 are milling the radii, facing the lugs and splitting. Four sets of mandrels are in service. While one set is being used, as shown in Fig. 7, the operator is setting up another. After milling the radii this set is placed in the next fixture, Fig. 8, where the lugs are milled and split. One man completes 250 rods on two milling machines.

Operation 16 is milling the clamp slot in the small end. It is a simple operation. One boy does 1,000 in 10 hr.

The time required for 100 connecting-rods is 35 hr., including trucking and inspecting which represents a creditable rate of production.



FIGS. 5 TO 8. DRILLING, MILLING AND FACING AUTOMOBILE CONNECTING-RODS

Fig. 5—Drilling holes for bolt in lugs. Fig. 6—Drilling and reaming pilot holes. Fig. 7—Milling radii on lugs Fig. 8—Facing lugs of rods

The Production of Gold in the United States in 1880 was $36,000,000, while in 1914 the total domestic yield was $94,500,000. The world's output of gold is approximately $460,000,000, of which the United States produces 20 per cent. It is not possible to give an accurate estimate of the total reserves of gold ore in the United States, but it is safe to assume that they are sufficient for a long period of years. Advances are being made in the mining and treatment of low-grade placer gravels by the introduction of larger and more efficient dredges that recover practically all of the gold in the gravel. As in years past, the supply of gold will continue to come from California, Alaska, Colorado, South Dakota, Nevada and Montana.

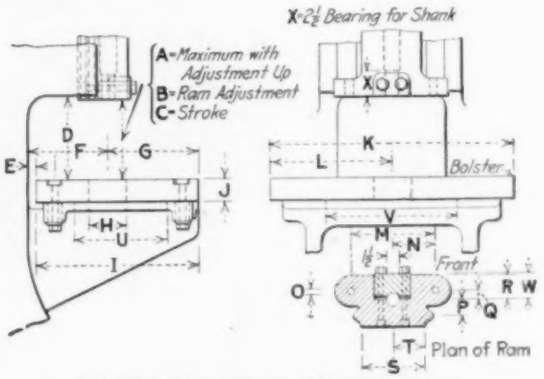
Letters from Practical Men

Data for Punch Presses

In the illustration are shown data on punch presses that may be found useful by designers in making punch and die tools to be used on No. 4 and No. 5 Adriance

No. of Press	Speed	A	B	C	D	E	F	G	H	I	J	K	L
4	100	8½	2½	2½	7¼	¼	7	7½	4½	14½	1½	22½	11 5/16
	150												
5	75	9	3½	3	9	1/16	8½	10	5	18 7/16	2½	27½	13½
	125												

No. of Press	Speed	M	N	O	P	Q	R	S	T	U	V	W
4	100	7½	3½	1½	2	½	2	5½	2½	10½	10½	2½
	150											
5	75	10	5	¼	2¼	1/16	2 1/16	7	3½	12	16	2½
	125											



PUNCH AND DIE DESIGNING DATA

presses. There are also supplied data required by the designer regarding the minimum and maximum sizes of tools which can be used in operating.

Hartford, Conn. W. F. O'Conner.

A Home-Made Paint Sprayer

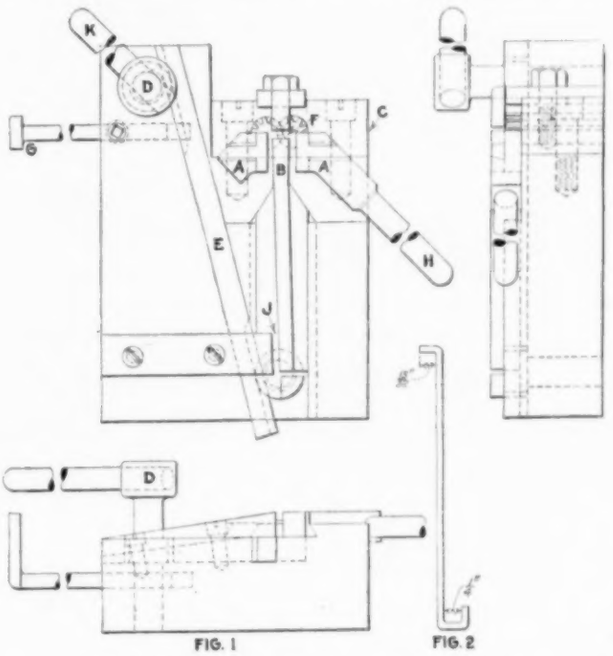
The paint sprayer illustrated requires very little description, as all essential dimensions and the method of construction are shown. It is connected to the air line at *A*, the air pressure being controlled by the handle *B*. Pressing this opens the air passage by forcing the valve *C* downward. The passage of air through the T at *D* forms a vacuum in the suction pipe *E* and draws paint from the bottom of the can through the pipe *F*. The amount of paint is regulated by the thumb-screw valve *G*.

This sprayer is primarily intended for painting coal or box cars, either wooden or steel, but can also be used in painting shop walls with oil or water paint, or even whitewash. It will be found extremely convenient in any shop having air available. Joseph K. Long.

Renovo, Penn.

Two Forms of Wire Benders

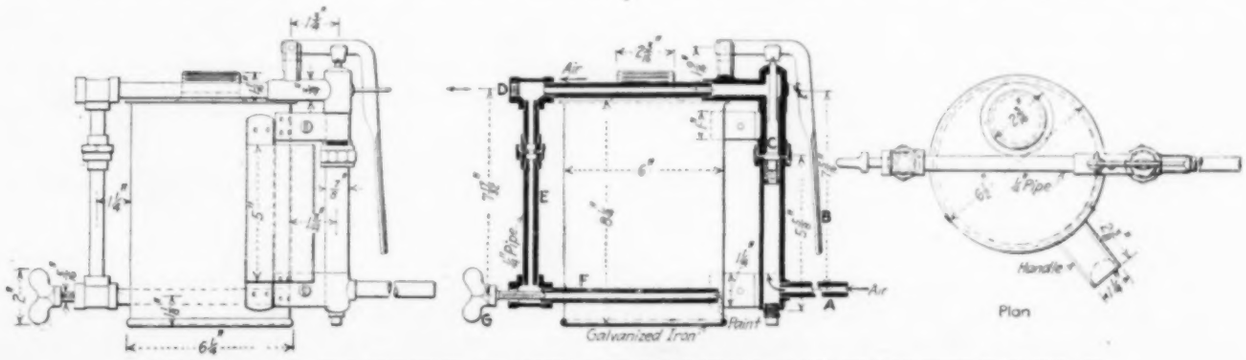
In another article are shown a few simple types of benders. In this article are illustrated two of a more complicated type, both using the brake bend. Both have been made exactly as shown and are capable of an



BENDING FIXTURE FOR SINGLE BEND

output of from 1,000 to 1,500 per hr. of No. 12 spring wire. Fig. 1 shows views of a machine that produces a bend as shown in Fig. 2.

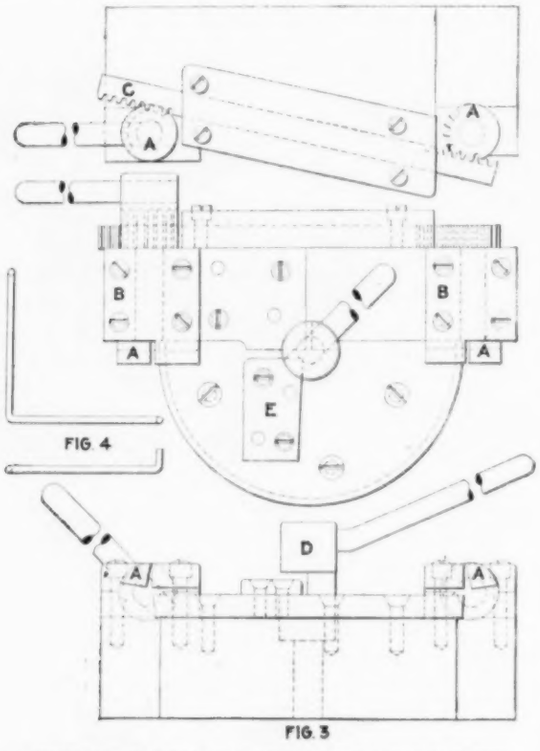
In Fig. 1 *A* are the double-brake benders, *B* the form, *C* the block which *A* works in, made of machine steel



HOME-MADE PAINT SPRAYER ADAPTED FOR SHOP WALLS AND OTHER GENERAL WORK

case hardened, *D* is a geared handle which actuates the rack *E* which makes the final bend.

In action both handles are thrown back. Place the wire in the slot *F* and against the stop *G* and pull the handle *H* the full stroke. This makes the double right-angle bend and introduces the extended length of wire



BENDING FIXTURE FOR RIGHT-ANGLE BEND

to the slot *J* or in position to make the final bend. Then pull the handle *K* to make this bend.

Fig. 3 shows another bender making one right-angle bend and two other right-angle bends in the opposite plane of the first bend, as shown in Fig. 4.

This machine works on exactly the same principle as the first shown. The first motion makes two right-angle bends, but farther apart. The second operation makes the single bend. *A* are the double-acting brakes or benders, which work in the bearing *B*. These benders have pinions at the rear which engage the rack *C*. *D* is a single-acting brake which bends around the block *E*.

Grand Rapids, Mich. F. C. Mason.

Small Parallels for Shop Use

There is no difficulty whatever in producing machine-shop parallels, provided the size is ½ in. or more, but there is considerable difficulty in making small accurate parallels. And when made, they will usually be found to have cost far more than is generally supposed, if anything like an accurate record is kept of the work. There are, however, a considerable number of commercial articles that can be used for parallels, and their cost is insignificant.

The first of these is the Woodruff key, which is known to all machinists. While the faces of these keys look somewhat rough, they will be found extremely close to any given measurement; and they have the advantage of being nicely graded in general size in relation to their thickness.

The common one-cent pieces, if new, will be found to run almost to measurements of precision, and they are most convenient for even quite large work. The only trouble connected with their use is the general desire of the human race to appropriate them.

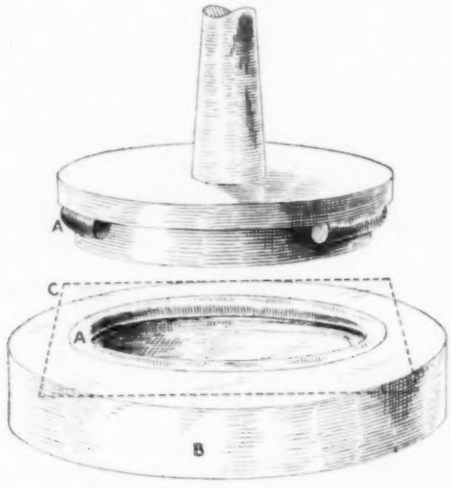
Perhaps the most precise work, when quantity is considered, will be found in printers' type. Ordinary type of a given size will, in one direction, show practically no difference, and for a good deal of machine-shop work no better parallels can be obtained. Since the introduction of cold-drawn squares and flats, there is at hand for parallels for general use a material that is very inexpensive, as it costs but a few cents per pound and only requires cutting off to be ready for use. When the price of these parallels is compared with the cost of those made of cast iron and planed up in the shop, it will be found that the cold-drawn material will be nearly 90 per cent. cheaper and just about as accurate. A. R. Nemour.

New London, Conn.

Attaching Emery Cloth to Disk

In the illustration is shown a method for attaching emery cloth to a disk. A ring *A*, ¼ in. in diameter, is made to fit into the recess of the disk.

This ring is then laid in the recess of the iron form *B*, and the emery cloth *C* is placed on the top of the ring.



ATTACHING EMERY CLOTH TO DISK

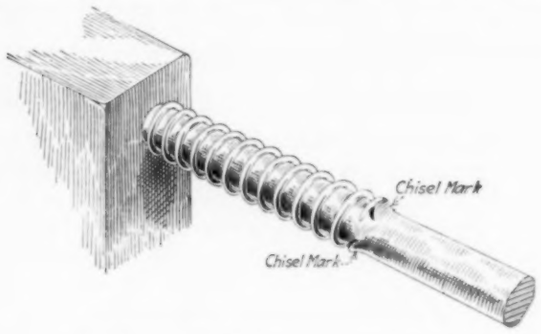
The disk is then forced down onto the emery cloth and into the ring. When the disk is raised from the form, the emery cloth is held to the face of the disk by the ring. The edges of the emery cloth are then trimmed off.

Naugatuck, Conn. A. E. Holaday.

Holding a Spring Without a Pin

The illustration shows a method of holding a spring on a spring pin, such as is used for backing up lock bolts and lock pins of various sorts, especially those seldom requiring removal. It will be noticed that by this method no pin is required.

It takes time to scribe, prick-punch and drill for a pin, especially if it is done on the assembly floor. By the method shown, two chisel marks serve the purpose



HOLDING A SPRING WITHOUT A PIN

equally well, and the work can be done much more quickly than by inserting a pin.

H. B. McCRAY.

Charles City, Iowa.

Tools for a Strap Holder

Simple tools that are perfectly satisfactory—under the conditions that govern both their design and use—give the greatest return for the thought and money spent on them.

A set of tools of this kind is illustrated herewith. The article to be made was a strap holder, or bracket, that was riveted to a loading tray. These loading trays are used in the navy for teaching the men rapidity in loading the guns. The appearance of the strap holders when riveted in place is shown at *A*, Fig. 1. Here it is shown in the final shape after bending, showing the position of strap slot and rivet holes.

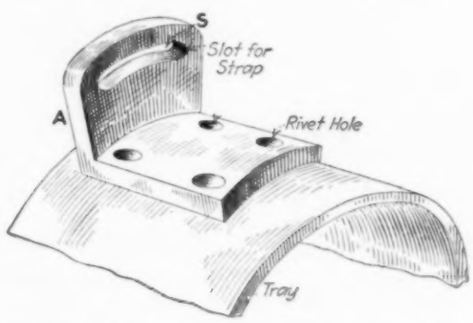


FIG. 1. THE STRAP HOLDER TO BE MADE

The operation to be performed for producing this piece was as follows: Blank from strip brass; bend to shape, including curve to fit tray; punch slot and drill holes for rivets.

There may be a division of opinion as to whether rivet holes and slot should not have been punched with a follow-on tool that would in one stroke also have punched the blank. This idea was dismissed for two reasons: The number of pieces to be produced did not appear to warrant the expense of such a complicated tool, and secondly it was thought that there was a very great probability that the slot *S* would be distorted in the subsequent bending operation. While this was merely an assumption, it was based on the very best of data, that is, previous experience with similar pieces.

The tools finally adopted were very simple and are shown in Figs. 2 to 5.

In the blanking tool, shown in Fig. 2, the cast-steel bolster *A* was turned to fit into a standard adapter on the press; it was slotted out to suit the punch *B*, the contour of which corresponded to the blank to be produced. The stripping plate *C*, which also acted as a guide for the strip at *G*, was secured to the press adapter by means of screws through holes *SS*, while the bolster was secured in the adapter by means of three cheese (fillister) headed screws as shown.

After blanking, the pieces of brass were bent to shape with the tool shown in Fig. 3, where *A*, the bottom tool, was turned to fit into the machine adapter and shaped at *C* to the contour desired. The upper tool *B* was of course shaped to coincide with *C*, allowing for the thickness of material.

The blank was located in position on the bottom tool by means of the two locating plates *P*, which were slotted so that they could be adjusted endways to give the best position for bending.

The slot was punched with the tool shown in Fig. 4. Here *A* is the bolster, *B* the punch and *C* a combined locating and stripping plate. When punching the slot, the strap holder was pushed under the stripping plate until the curved part met the curved edge of the stripper; then the punch was tripped and the work was withdrawn.

The four rivet holes were drilled in the two-part drilling jig, shown in Fig. 5. In this figure, *B* is the base and *P* the jig plate carrying the four bushes. Both

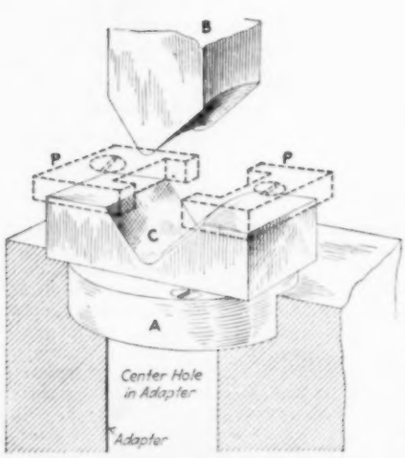


FIG. 2. THE BLANKING DIE

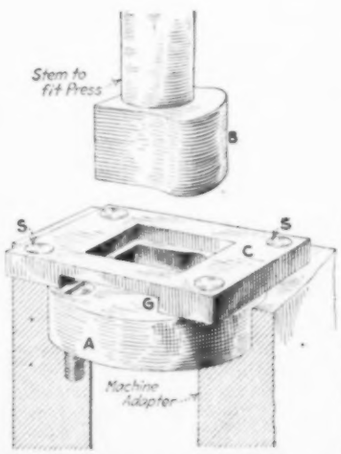


FIG. 3. BENDING THE STRAP

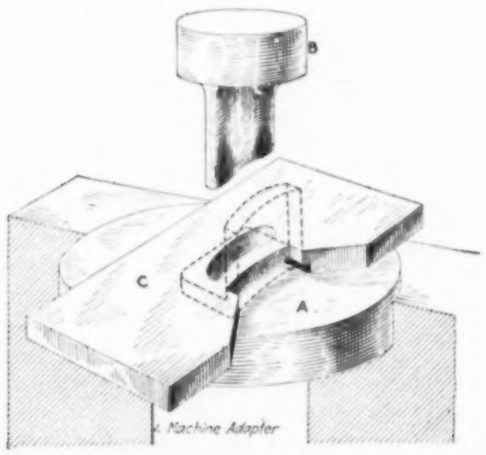


FIG. 4. PUNCHING THE SLOT

are machined to the curvature of the piece to be drilled, as shown by end view and part section at *XY*. Plate *P* is retained in position on the base by means of screw *S* and stops *M*, and the work is located in the jig by ridges at the side of the curve on base *B* and endways by the end of plate *P* and the stop pin *L*. It is secured in position by means of a wing nut and screw.

The slot *K* in plate *P* was to clear the web of a small casting—of the same curvature as the strap holder—that

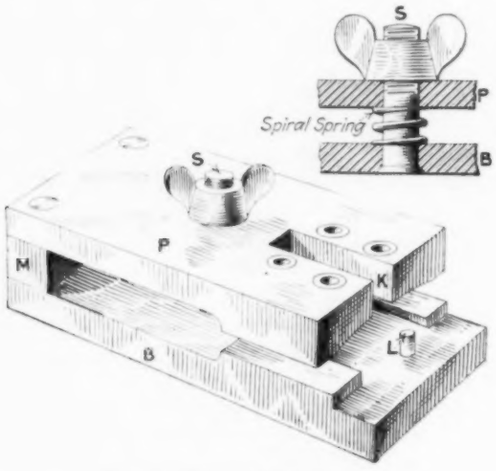


FIG. 5. THE DRILLING JIG

also had to be drilled. It is quite possible that the knowledge that a drilling jig would be required for this casting had some weight in the decision to drill the rivet holes in the strap holder instead of punching them.

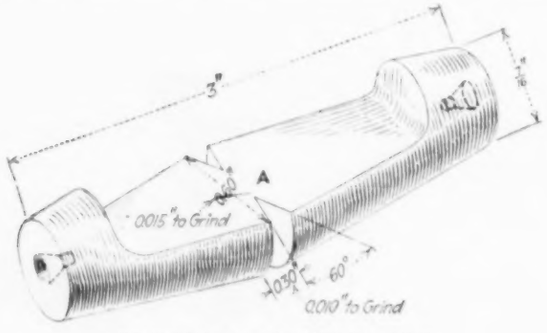
The whole set of tools as described worked particularly well, and though simple and cheap they were thoroughly efficient in action. WALTER G. GROOCOCK.

Guildford, England.

Thread and Center Gage

The illustration shows a handy tool for those who have to cut accurate threads. It is for setting the threading tool at right angles to the axis of the piece to be chased and also to set the tool on dead center.

A piece of $\frac{11}{16}$-in. machine steel is turned as shown, leaving 0.015 in. to grind on the center dimension of



THREAD AND CENTER GAGE

$\frac{3}{8}$ in. This $\frac{3}{8}$-in. flat is to make it easy to get the diameter of 0.60 in. with the micrometers. The V is made with a fine-pitch thread tool.

The piece is now milled as shown, leaving 0.010 in. to grind on the 0.30-in. dimension. After pack hardening, a piece is soldered in the center so that the 0.60-in. dimension can be calipered or measured. This done, the soldered piece is removed and the face *A* ground for the dimension of 0.30 in. The V is ground in a bench lathe and lapped.

The tool is now completed, it being understood that all grinding has been done on centers, as the tool itself is always used on centers.

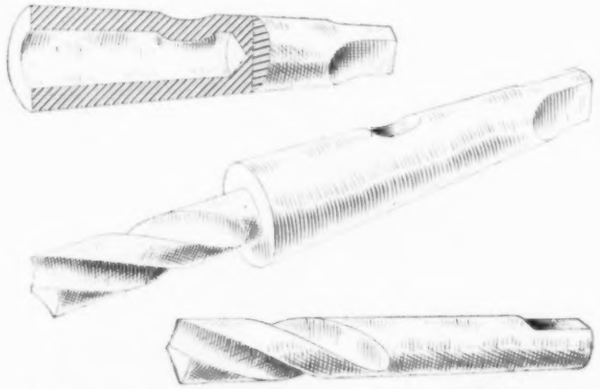
When this tool is placed on the lathe centers the thread tool is set into the V, and the center height is shown by the surface *A*, the gage being turned one-half a revolution so as to bring the surface *A* on top of the thread tool. The thread tool is raised until there is no movement felt in the gage. On taper thread work this will help to set the tool at right angles to the axis of the piece.

Bridgeport, Conn. JAMES MCINTYRE.

Economy in Utilizing Broken Taper-Shank Drills

We use a large number of taper-shank drills, mostly in sizes below $\frac{13}{32}$ in. The breakage was heavy and the difference in price between taper-shank and straight-shank drills was considerable. Owing to the requirements of our work, it was impossible to use a chuck for holding these small drills, as the holes were close to parts interfering with the body of the chuck.

In order to use a straight-shank drill, we gathered up the broken taper shanks and drilled them out to exactly



USING TAPER SHANK OF DRILL TO HOLD STRAIGHT SHANK DRILLS

the size of the drill to be used. We flattened the back end of the sleeve and made a corresponding flat on the end of the drill, thereby giving us a taper-shank drill. One taper shank answers for any number of broken straight-shank drills, and we have a taper-shank drill for service.

This may not be a new idea, but it has saved us a lot of money. E. A. CLARK.

Joliet, Ill.

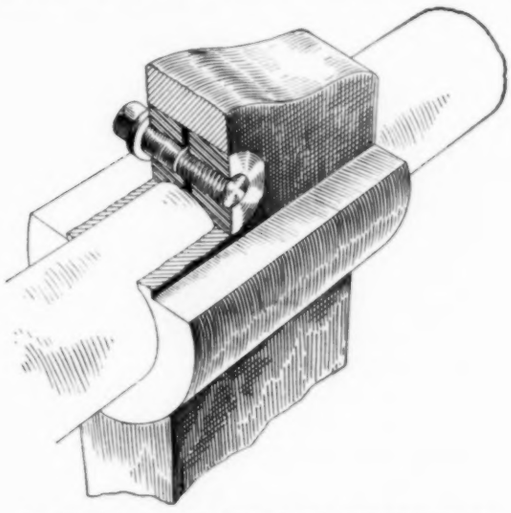
The Production of Silver in the United States has gradually increased, until in 1914 the total amount produced—the largest ever recorded—was 72,400,000 oz. The silver production of the world is about 225,000,000 oz. annually, of which the United States produces one-third. Practically three-fourths of the world's silver production is derived from North America. There is every reason to believe that the United States will continue to retain its position as the largest producer of silver and have a large surplus for exports. Vast quantities of low-grade complex ores carrying silver with lead, copper or zinc are now unworked in the Western states because of the lack of processes by which the metals can be recovered at a profit.

Discussion of Previous Question

Best Way To Do Certain Things--Rocker-Arm Fastenings

On page 1177, Vol. 43, M. V. Terry, in connection with Professor Sweet's article on page 936 on securing a rocker arm to a shaft, shows the split rocker arm. This often introduces an element of weakness at the binding point.

To avoid this defect I have adopted a common form of binder used for holding the shanks of tools in the turret of hand screw machines and turret lathes. I have usually seen rocker arms made with a slight hub on each side of the web. This method consists in drilling the rocker-



CLAMPING A HUB WITHOUT SPLITTING IT

arm hub at a right angle to the center of the shaft hole, which is laid out so that the binding screw will just clear its circumference.

This screw hole is then counterbored about ¼ in. larger, cutting into the circumference of the shaft hole before the latter is bored and going completely through the hub. A plug of the same length as the hole is fitted to drive in it, then chucked and tapped for a collar-head capscrew and counterbored to body size a little more than half its length. The plug is driven in and the shaft hole bored in the rocker arm. Then the plug is driven out and eased to a good sliding fit in its hole. A small segment of a circle, which represents part of the circumference of the shaft hole, is now cut in the plug, which is divided by a thin saw into two pieces at the deepest part of this cut. The plug then represents the jaws of a vise drawn together with the collar-head capscrew. It is placed in its hole in the rocker arm with the screw in place, turned until the cuts in the two parts match with the shaft hole, when it is ready to be slipped on the shaft and to be set in position.

This fastening is a very old and a very good one and can be used in a great variety of ways. It holds so well that in many instances I have found a key unnecessary. It never mars the shaft. If it sticks, a slight rap on the head of the screw after it has been slacked loosens it. If the piece it is used upon has no key and requires adjustment, it can be moved either much or very little and will stay exactly in the position in which it is set, without moving when it is clamped again. The boss on the hub for binding need not project so far from the hub; and in case the boss is in the way or is not wanted, it can be omitted, the hub made slightly larger and the shaft hole bored enough out of center with the hub to allow room for the binding plug and screw in the proper place. The accompanying illustration shows this method of securing a rocker arm to a shaft. J. P. POLAND.

Springfield, Mass.

Adjustable Stop for Automatic Screw Machine

The adjustable stop described by Mr. Hoffman on page 80 is a part of the regular equipment of the Cleveland automatic screw machine. In fact, it is about the only style of stop that can be used on the Cleveland turret type of machine, on account of the shoulder, which prevents the stop from being forced back into the turret when feeding stock at high speed. I have known of several disastrous accidents that happened to the No. 0 Brown & Sharpe automatic screw machine through the use of this style of stop.

One case I have in mind was where a long piece was being made on the machine. In feeding out stock, the end of the rod fell between the front end of the feed tube and the stop, which was a shouldered one such as Mr. Hoffman's shows. The result was that three teeth were sheared off on the lead camshaft gear. This probably would not have happened, if a plain stop without a shoulder on it had been used, as the stop would then have pushed back in the turret without injury to the machine. I would also suggest that a clever operator would cut off stock without having a teat on the end of the piece.

New York City. FRANK H. SAGE.

Helping the Standard-Price Man Get Off

Frank C. Hudson need not worry about the short memory of the buyer. The conditions to which he refers on page 1121, Vol. 43, are too aggravating to be soon forgotten. Not only that, but the effrontery of some of the manufacturers of machine and small tools gives every indication of continuing right up to the very day when the bottom is going to drop out of the market—and it is surely going to drop, for arrogance brings its own reward.

It is not all a matter of price, however. Orders for special attachments for machines already in use, for example, are treated with scant courtesy. That great word "Service" seems to have been put on the shelf for the present.

But then, as Mr. Hudson states, it is not a case of "everybody's doing it." The courtesy and coöperation of those who have not lost their sense of proportion are made more evident by contrast. They may rest assured that the buyers are appreciative and will reciprocate.

Jersey City, N. J. H. D. MURPHY.

Empirical Design of Gas-Engine Piston Pins

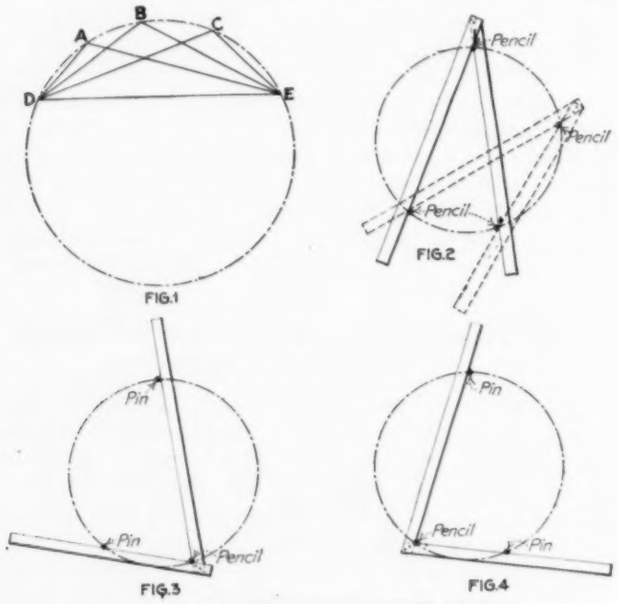
Messrs. Lewis and Kessler, on page 111, give formulas for making piston pins for gas engines. I do not know whether there is much relation between a gas-engine piston pin and a steam-engine crosshead pin, but the work would seem to be nearly enough alike so that what would be good for one would be good for the other.

In about thirty years in the steam-engine business we did not learn much, but did find out some things; and one was that a cast-iron crosshead pin was a lot better than a hardened tool-steel one. To get the most bearing surface possible, we gripped the crosshead pin in the connecting-rod and gave the rod 1/4-in. clearance, so as to give the bearings end play. When I say the cast-iron pins were a lot better, that is just what I mean. The professor may want to know what kind of cast iron we used. I do not know and never wanted to know, but I can say that they were never hard, unless by accident, as we never made hard iron if we could help it. We made the pins large enough to get generous measuring surface, and hollow to make them light. JOHN E. SWEET.

Syracuse, N. Y.

Beam Compass for Large Arcs

On page 953, Vol. 43, H. O. Smith describes a beam compass for drawing large circles. If he will investigate a little closer he will find that, while the instrument draws parts of a circle, it is not of the chord he thinks but



BEAM COMPASS FOR LARGE ARCS

a part of a circle whose chord extends from one of his pin points to the other.

Some years ago I contrived a beam compass that worked on this principle. It was suggested by the fact that you can always draw a circle through three points if they are not in a straight line. Geometry tells us that all angles formed by drawing lines from the ends of any chord to points in the circle are the same for any particular chord. The angles *A*, *B* and *C* in Fig. 1, no matter where they are located on that part of the circle on the same side of the chord and standing on the chord ends *DE*, are all the same. This being true, any one of the three points can be the pencil point of our trammel, and with the other two pin points to guide the straight edges of the trammel, we get the same circle.

Figs. 2, 3 and 4 show circles of the same size, with the three pins located in the same position in each, and with the trammels in place and the pencil occupying a different one of the three points in each.

Fig. 2 shows the trammel, or beam compass, in two positions. Large-angled trammels slide more freely over the pins without springing the trammel.

Stockton, Calif. M. JACKER.

New Design for Reducing Gears for Aero Propellers

The article by Mr. Balkachine, entitled "A New Design for Reducing Gears for Aëro Propellers," on page 78, Vol. 44, calls for some comment.

He makes the following statement: "Epicyclic gearing was tried, but it could not be made small enough. I finally came to the idea of a stationary pinion as a means of reduction, and the whole device took the shape shown herewith."

Apparently Mr. Balkachine believes himself to have discovered a new form of mechanism. He has not. His mechanism is an epicyclic train, pure and simple, in which one of the gears of the train is locked and the arm is free to revolve. His stationary pinion is the locked gear; and his spider, or cage, as he calls it, is the arm of the gear train.

One inherent fault of epicyclic trains lies in the power consumed in friction. Given the same materials, workmanship and finish, Mr. Balkachine's mechanism will have a lower mechanical efficiency than the mechanism patterned after the back gears of an engine lathe and designed to give the same reduction ratio—1,200: 533.

But this is not all. The ball bearings on which his planetary gears are mounted actually run at 1,200 r.p.m. while being subject to pressure resulting from transmission of power at 533 r.p.m. This necessitates the use of larger and heavier ball bearings, as the size of the latter is a direct function both of pressure and speed.

While I am not sufficiently acquainted with aëronautics either to condemn or recommend Mr. Balkachine's mechanism for aviation purposes, it appears to me that the unfortunate combination of lower mechanical efficiency and greater weight would constitute a rather serious obstacle in the way of its general adoption in a field where weight and maximum power are of prime importance.

Flint, Mich. M. V. TERRY.

The World's Production of Copper is approximately 2,211,000,000 lb., of which the United States produces 60 per cent. and consumes about 41 per cent. of the world's output of copper, or 65 per cent. of our own production. One of the most remarkable advances in mining in this country has been in cheapening the cost of handling copper ore.

Editorials

The New President of the Hill Publishing Company

Arthur J. Baldwin has been elected President of the Hill Publishing Co., to succeed the late John A. Hill.

Mr. Baldwin is a lawyer and a member of the firm of Griggs, Baldwin & Baldwin. For the past ten years Mr. Baldwin has devoted himself almost exclusively to business problems and has been identified with large business enterprises.

At the present time he is treasurer of the Rogers Silver Plate Co.; treasurer of the Borough Development Co., which has a contract with New York City for the removal of ashes from Brooklyn; treasurer of the Boston Development and Sanitary Co., which handles all the garbage and ashes for the City of Boston; vice-president of the Automatic Fire Protection Co. and secretary of the Mississippi Wire Glass Co.

Mr. Baldwin has been for the past ten years Mr. Hill's intimate friend and business adviser and brings to the company an intimate knowledge of Mr. Hill's policies and plans.

Mr. Baldwin has arranged his business affairs to take active charge of the interests of this company. The organization will remain intact, the plans and policies so ably devised by the founder of the business will be carried forward, and the standards of practice will be upheld.

Scientific Method of Attack

A man named Newton, while lying under an apple tree one day, saw an apple fall. The occurrence was remarkable in that it led to the enunciation of the laws of gravitation. No doubt a great many men had noticed apples falling long before Newton's time; the difference between those other men and Newton was that Newton thought about it. Why did the apple fall? Why down? Why so fast? How fast?

Such studies are in the realm of "pure" science, so called—that is, abstract science. The method of research is to observe a phenomenon, think about it, pick it to pieces, study the parts and finally put them together. This procedure is called the scientific method.

This method of attack is useful in other places than in scientific laboratories. Its principal feature is the requirement of thought, which is of universal application. A homely case in which this attack was finally successful is set forth in the story about a loom in a cotton mill.

The loom had the habit of throwing out the shuttle every once in so often—out through the window, down three stories to the ground. It became tiresome to the weaver to make so frequently the round trip downstairs to retrieve his shuttle, so he complained to the loom fixer, who nailed a piece of tin over the window pane favored by the shuttle. After that, the shuttle would strike the tin and fall to the floor, and its replacement was simple. All went well until the overseer saw the piece of tin; his mind cerebrated and caused him to have the loom fixed so that it would not throw out the shuttle.

Every day's work in the plant is filled with cases just like this one in principle. If the scientific method—the thoughtful, reasoning method—is used in attacking a problem, the answer is usually correct and satisfying, whether the problem is one of finding out why a pump won't pump or what is the best way to bore high-explosive shells.

The trouble usually is that those in charge have not the time to sit and think out the right answer. As a rule, the supervisory force is so busy getting the work done that there is no time to spend in meditation. Meditation looks too much like loafing.

It begins to appear, however, that there is a profit to be had from so arranging the work among the members of the supervisory force as to permit some of them to spend their time thinking for the benefit of the firm, bringing to bear on production problems their previous experience combined with their present thought in the same way that an engineer or a draftsman solves an engineering problem. In a nutshell this is all there is to modern management.

Cutting Downward in the Lathe

A visitor in Continental machine shops has undoubtedly seen instances where engine lathes were "running backward," or "cutting downward." If he inquired the reason, he was probably told that the lathe chattered less on this backward cut and was run in that way to get a smooth finish on the work. To this explanation the American probably replied mentally, if not aloud, "Why not tighten up the spindle boxes, or grind the tools properly, and get rid of the chatter in a workmanlike fashion?"

On rare occasions this same practice is seen in American shops, where foreign-trained workmen, particularly French and Swiss, are employed. While the imagined comment of the American observer is natural and applies here with the same force that it does abroad, it is worth while considering just a little further to make sure that the European practice is unjustified even from the American viewpoint. It probably is justified from European practice.

At the outset of such a consideration, we must recognize one general difference in design between foreign- and American-built lathes. With the flat ways of the European-made machine, it is customary to gib the carriage both front and back. American-made lathes are commonly gibbed at the back, but not at the front; and further, American lathe builders do not arrange spindles so that the lathe can be run backward without the danger of unscrewing the chuck or faceplate. The only exceptions are probably in the field of toolroom or precision lathes. That there might be some advantage in changing this last detail is shown by the fact that we occasionally find chucks or faceplates that have been set-screwed to clamp them to the spindle nose. The end of

the setscrew is of course provided with a brass plug, or "mouse," threaded the same as the spindle, so as not to mar it.

The construction of the foreign lathe is such that the lifting effect on the tool when the lathe is run backward is taken by the front gib. The lifting effect on the tool in the case of American lathes similarly run would be resisted by the weight of the carriage and apron.

Turning now to the forces acting on the tool and the work, in forward running we have the upward thrust of the cut resisted by the weight of the spindle and the work, and the pressure of the spindle bearings. The pull of the belt is upward. The relative amount of these resisting pressures and this weight varies with the size of piece, size of lathe, cut taken and kind of tool used. In small lathes the pull of the belt is undoubtedly sufficient to overcome all the others. With large lathes we can imagine a situation where the spindle is floating in its bearings—a condition that may easily lead to chattering unless the boxes are very tight.

With backward running, however, or "downward cutting," we have the pressure on the cut acting in the same direction as the weight of the piece and the weight of the spindle. In a belted lathe the belt pull is the only upward force. Thus all the forces except belt pull act in a way to press the spindle down into the lower halves of its bearing instead of trying to lift it out of them. Thus there can be no tendency to float.

An identical relationship of the forces exists if the cutting tool is transferred to the back and the lathe run forward as normally. This is a condition of "downward cutting."

Many older British lathes were arranged so that downward cutting with a tool on the back of the rest was possible. The slide rest was an independent part in many cases and was bolted to the saddle, which had a number of T-slots so that the former could be secured at almost any angle with relation to the work. With these rests it was an easy matter to invert a tool and use it at the back.

The ordinary hand-screw machine is an example of a machine so designed that cross-slide tools can be used both front and back, those on the back cutting downward.

These facts, which tend to show that downward cutting may lead to the practical result of less chatter, suggest the question, "May there not be very good reasons why the Continental machinist sometimes runs his lathe backward, odd as it looks to American eyes?" And another immediately follows, "Why should not lathes—at least small ones for accurate work—be so designed that they can be run in either direction, depending upon the kind of work to be done?" Or if not in either direction, why should they not be designed to carry a tool post on the back of the slide rest to permit downward cutting with the lathe running forward?

How do we know but that there are some kinds of work, particularly small, light pieces, that can be machined better with a lathe running for downward cutting? It would surely be a simple thing so to construct lathes that they could be thus operated and still have the tools rigidly supported at the proper height. Is not this suggestion of sufficient importance to warrant consideration and perhaps experiment.

Our Industrial Mobilization

There is a difference of opinion as to the kind of men who should be selected to plan our industrial mobilization. Preliminary meetings have been held by the governing bodies of some of the five national engineering societies invited by President Wilson to nominate men for this work, but at this writing no society has announced its selection.

These men, when appointed, will be charged with grave responsibility. The success or failure of the present attempt to organize the manufacturing resources of this country into a unit that will be instantly available for the support of our armed forces in a national emergency will be in the hands of these engineers. The patriotism of the manufacturer will be insufficient to meet such a crisis when it comes. In preparing for that time someone must have spent many anxious weeks and months of planning. Under the proposed plan the state committees selected from the ranks of the engineering societies in coöperation with the present Naval Advisory Board are charged with this far-reaching duty. In a great measure the final outcome of the project is in the hands of the men yet to be appointed.

The first qualification that they must possess is a record that will win the support of manufacturers and the American people. They must command respect and confidence. They must have a wide technical experience in manufacturing. They must be men of matured judgment and possessed of a far-seeing grasp of present and approaching industrial conditions. The amount of work to be accomplished is tremendous. Thus each one must be so situated that he can divert a large amount of time from his regular business, as well as assume the accompanying expenses. The present plan provides that these engineers shall work without compensation of any kind, and they will not even be allowed traveling expenses by the Federal Government.

This brief analysis of some of the principal qualifications of these representative engineers shows that men with certain connections must be at once eliminated from consideration. Men who are today actively engaged in the manufacture of munitions and men who are connected with financial interests that have been handling European or American munition contracts will never have the confidence of the American people. The public will, expressed through Congress, will not permit American manufacturers to make large profits out of their work for national preparedness. Thus any man who is directly or even remotely connected with the manufacture of munitions today will be looked upon with suspicion; and justly or unjustly, his motives would be questioned if he should attempt to serve upon any one of these committees for the mobilization of our industrial resources. The only men who will be acceptable are those who have excellent records as organizers or manufacturers, whose patriotism is unquestioned and who are entirely free from any direct or indirect connection with munition manufacture.

Upon the national engineering societies is placed a grave responsibility in the selection of their candidates. Unwise nomination might seriously jeopardize the entire plan.

If you suspect a man, don't employ him; if you employ him, don't suspect him.—Chinese Proverb.

Shop Equipment News

Portable Floor Crane

This crane is known as the Brownhoist portable floor crane and is made by the Brown Hoisting Machinery Co., Cleveland, Ohio. It is intended for all-round shop use where overhead construction, belting, shafting or the like

PORTABLE FLOOR CRANE

Made in three styles: No. 1—capacity, 1½ tons; maximum lift with tackle, 5 ft. 5 in.; overhang, 2 ft. 3 in.; width clear between front wheels, 1 ft. 11¼ in. No. 2, or garage type—Capacity, 1½ tons; maximum lift, 6 ft. 8¾ in.; overhang, 3 ft. 1 in.; width clear between wheels, 3 ft.; wheel base, 4 ft. 2½ in. No. 3—Capacity, 3 tons; maximum lift with tackle, 7 ft. 6 in.; overhang, 3 ft. 1 in.; height over all, 9 ft.; clearance between front wheels, 3 ft.; diameter of front wheels, 10 in.; swivel wheels, 7 in.; height of truck bed, 11 in.

prevents the use of other types or where infrequent use would not justify installing an overhead system.

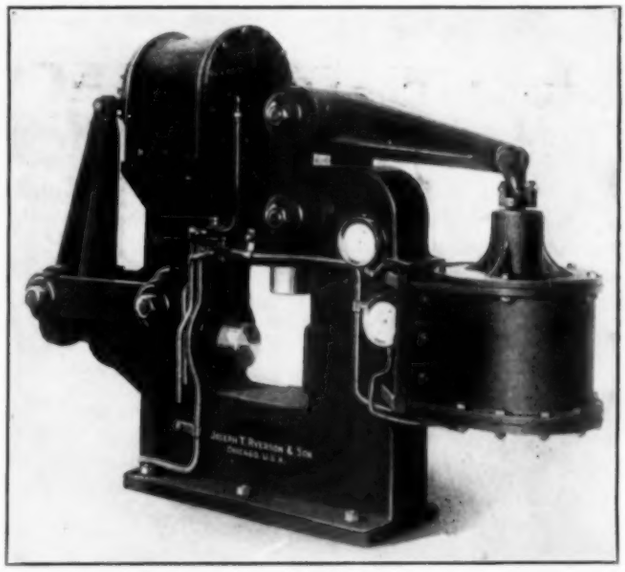
The crane frame and truck are steel castings. The supporting wheels are large and set well apart, so that the crane will not upset by side pulls on the load. A narrow-gage swivel truck is provided at the front, fitted with a handle for hauling and steering the device. By placing the handle in an upright position a wheel brake is automatically applied, keeping the crane stationary while hoisting or lowering a load. The hoisting is done either with a self-contained compact winch or by means of a triplex chain block.

On the winch type, which is illustrated, the operating handle is so placed as to be turned without interfering with any load. The winch has wire-rope drum, large cast-steel main gear, cast-steel pinion, all-steel shafts and is fitted with substantial ratchet and pawl hoist-check and with steel hand cranks. The bottom tackle block is of steel plate, side type, with one large sheave and drop-forged swivel hook. The tackle is arranged for either two-part or three-part rope, and the top sheaves are supported directly on the frame and housed in one-piece rope guards.

A Heavy Pneumatic Spring-Banding Press

The machine shown is especially designed for railroad and commercial spring-manufacturing and repair shops that are not equipped with hydraulic power.

It is operated by compressed air, the cylinders being of such size that with air pressure of 100 lb. a pressure of 60 tons is exerted on the rams. By means of both horizontal and vertical rams a positive and known pressure is exerted on the spring band, which insures uniform and



PNEUMATIC SPRING-BANDING MACHINE
Capacity, 60 tons; diameter of cylinders, 16 in.

rapid work. Each machine is furnished complete with three-way hand-operated valves and the necessary pressure gages.

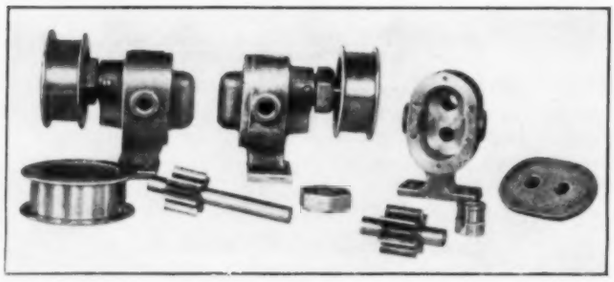
The machine is a recent product of Joseph T. Ryerson & Son, Chicago, Ill.

Gear Pump for Lubricants

At first sight the gear pump shown assembled and in detail differs but little from similar types on the market. This pump, however, has been designed and made with unusual care. All parts are interchangeable.

The cast-iron body is accurately bored in a special fixture. The pulley shaft runs through a bronze packing gland machined true with the adjusting nut. This nut is large and so placed as to be easily reached with an ordinary wrench at any time without the necessity of disturbing the pulley. The gears are made of steel, pack hardened, and then the shafts and ends of the gear teeth are carefully ground to size.

The outside diameters of the teeth are ground to fit the pump bores. The grinding is all done true with the gear pitch, so that the meshing is as perfect as possible when assembled in the pump. Screw oil holes are placed



GEAR PUMP FOR LUBRICANTS

Gears, 1½ in. in diameter by 1⅛ in. long; shafts, ⅝ in. in diameter; body, 4¾ in. high, tapped for ¾-in. pipe; pulley, 3 in. in diameter for 1-in. belt

on each side of the drive shaft, so that it can be properly oiled no matter what the position in which it is placed or what liquid is pumped. Various-sized bases or bolting flanges are furnished to suit conditions.

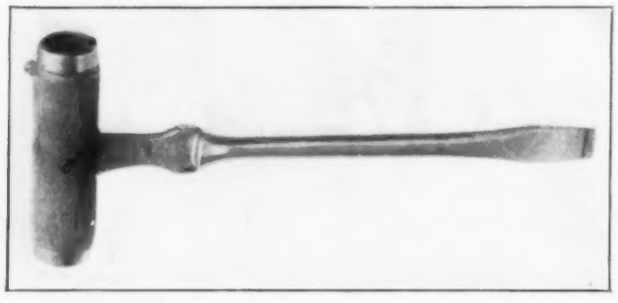
These pumps are manufactured by the Stevens Manufacturing Co., Dayton, Ohio.

Handy Combination Tool

The tool shown is designed to meet the requirements of both a screwdriver and hammer.

In the position shown, with the handle turned to form a T, the tool can be used as a hammer, and the T-handle provides increased leverage for use as a screwdriver.

The handle is slotted so that when use as a straight screwdriver is preferred, the knurled handle may be



COMBINATION SCREWDRIVER AND HAMMER

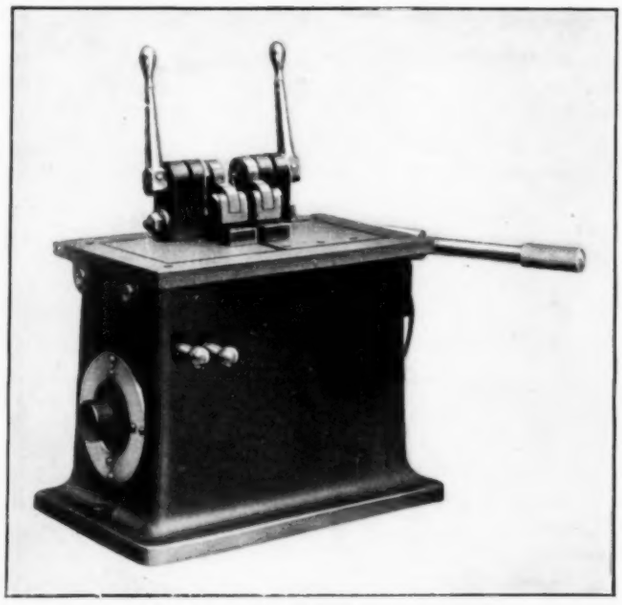
sprung over the flat shank to furnish a well-fitting straight handle.

This tool is made in a number of sizes by the Crescent Tool Co., Jamestown, N. Y.

Portable Electric Butt Welder

The electric butt welder here shown has about the proportions of an ordinary typewriter and is intended for welding iron, steel, copper, brass, or semiprecious metals. Its small size and weight make it easily portable.

The two levers shown upright at the top operate eccentric bushings and are for adjusting the jaws, or clamping devices, used to hold the work to be welded. The lever at the right is for upsetting the material, and at the same time the current is switched on by simply twisting the handle. The two knobs projecting from the front, toward the left, are for adjusting the table. By moving them in



PORTABLE ELECTRIC BUTT WELDER

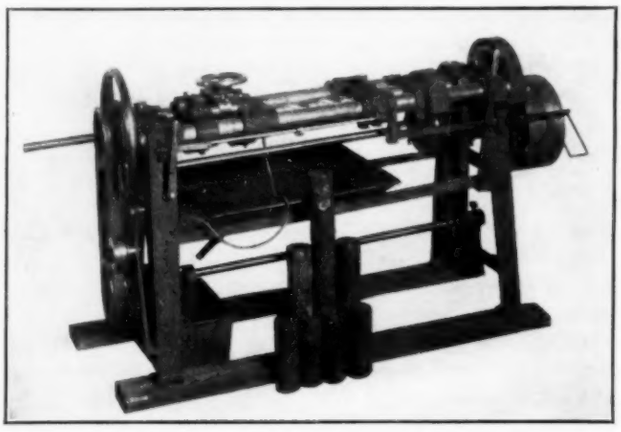
Largest diameter of stock that the machine will weld, ⅝ in. round, or equivalent in other shapes; maximum amperage, 15; size of base, 14x16¾ in.; height of base, 10 in.; height over all, 18 in.

or out, the table is raised or lowered, or moved back and forth in a horizontal plane. This permits a very accurate adjustment for welding the finest material.

The machine is made by the Detroit Electric Welder Co., Detroit, Mich.

Horizontal Drilling Machine

The machine shown was designed for drilling 18-pounder high-explosive billets. On this class of work the chief advantage claimed for the horizontal type of



HORIZONTAL SHELL-DRILLING MACHINE

Tight and loose pulleys, 16x3½ in.; power required, approximately 5 hp.; speed, 600 r.p.m.

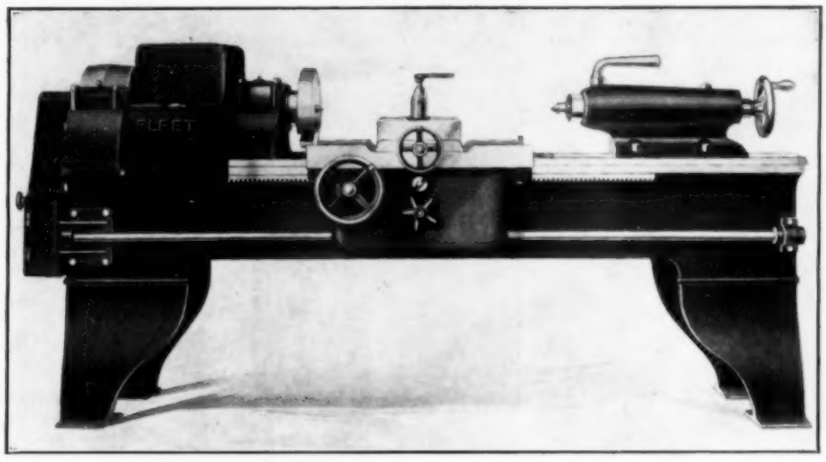
machine is the ready manner in which the chips free themselves from the hole, thus avoiding a binding action on the drill.

A quick-return shell vise is operated by means of a foot treadle and belt drive. The feed is automatically cut out by means of a trip-rod on the side of the machine. A movable stop operates to cut out the feed when the required depth is reached. This machine is made by the A. R. Williams Machinery Co., Toronto, Canada.

Heavy-Pattern Engine Lathe

In the design and construction of the lathe illustrated the aim was to provide capacity for the utilization of high-speed tools.

The bed has one large V in the front and one flat way in the rear for the carriage. The geared headstock, with single-pulley drive, affords two speeds in the head, which with two speeds on the countershaft furnish a four-speed machine.



HEAVY-DUTY SINGLE-PULLEY ENGINE LATHE

Swing over bed, 18 in.; swing over cross-slide, 9¼ in.; distance between centers, 36 in.; drive pulley, 12x6½ in.; length of carriage bearing on bed, 30 in.

The spindle bearings are self-oiling by means of rings from a reservoir beneath. The apron is made in a complete double-wall or box section, giving all studs and shafts an outboard bearing. The feed drive consists of two steel sprockets and chain. The feeds, per revolution of spindle, are 0.020, 0.040, 0.060, 0.080 and 0.100 in.

The machine is built with any length of bed, from 8 ft. up, by the Standard Lathe and Tool Co., Cleveland, Ohio.

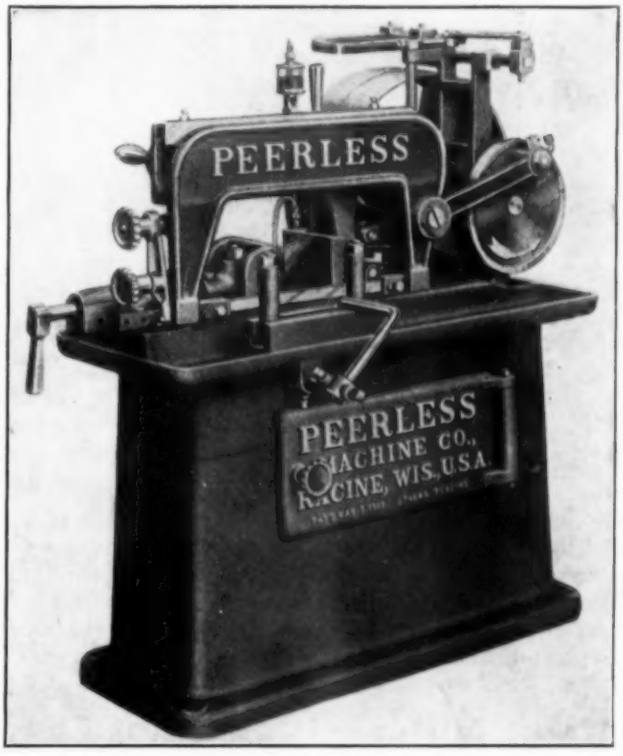
High-Speed Power Hacksaw

It will be observed that full cabinet construction is provided in the high-speed hacksaw machine shown. At the bottom of the cabinet is formed a tank for the cutting compound, the pump for circulating which is located inside the rear end of the cabinet. The cutting compound, after flowing on the blade and the work to be cut, is collected, together with the chips, in a separate pan located inside of the door in the cabinet, shown on the right-hand side of the machine. In this pan the compound is separated from the chips, is turned back into the bottom of the cabinet and again circulated.

The saw blade, which travels in a center line of the saw guide and connecting-rod, thus eliminating any tendency toward side pull, is clamped solidly in a special clamping device and secured at each end with straight steel hardened pins. The saw table has T-slots on each side of the vise used for clamping down any work of irregular shape. This vise is quick acting, having 1 in. of screw adjustment. The screw is inclosed, to protect it from damage. A special quick-acting attachment that prevents the jaws from tilting is also provided for cutting short pieces.

The feeding mechanism is by a spring so arranged that it has the same effect as if a weight were used, giving a uniform pressure on the blade throughout the entire cut, the pressure being instantly changed and controlled by a lever on the left-hand side of the machine. When the lever is down, there is no pressure on the blade; when at the top notch, a pressure of 125 lb. is provided. The automatic lifting mechanism is also by spring, the saw frame being overbalanced by this spring. On the main shaft is a cam that allows the feeding spring to act only on the cutting stroke, at the end of which the cam releases the feed. As the saw frame is overbalanced, it automatically raises and clears the blade from the cut until the end of the return stroke, at which point the cam again allows the feeding spring to come into action. It will be noticed that both the feeding mechanism and the automatic lift have the same action as by gravity, or if a weight were used, and are therefore positive in their action.

The feeding mechanism is controlled by the belt shifting lever. When the belt starts to shift, the machine begins operation. The feed does not come into action until the belt has been shifted three-quarters of its movement, at which point the feed mechanism is thrown into action. This allows the cutting compound to get on the blade and the work to be cut, before any feed pressure is applied. It also allows the operator to apply a little pressure on the blade by pressing down the handle, shown



HIGH-SPEED POWER HACKSAW MACHINE

Capacity, 6x6 in.; tight and loose pulleys, 3x16 in.; main shaft, 1 7/8 in.

on the saw guide, until the machine has made a few strokes, thus avoiding the likelihood of stripping the teeth. If preferable, the feed can be entirely released by dropping down the feed lever on the left-hand side of the machine. By gradually raising the lever the pressure is also gradually applied on the blade, so that it has a chance to start without being forced sidewise. This provides an extremely sensitive feed.

The dropping of the saw frame, in case of blade breakage, is eliminated in this machine. In case of such accident the feeding is increased until the saw has finished its cut, when the machine is automatically shut off in the regular manner. As the feeding mechanism is controlled by the belt shifter, the feed is always released before the machine stops, allowing the saw frame to rise automatically. Both height and depth gages are provided. The bearing on the saw frame, which travels in V-shape slides, is 11½ in. long.

This machine is the latest model of the Peerless Machine Co., Racine, Wis.

Sand Blasting Helmet

The sand-blasting helmet shown was designed to afford complete protection to the operator and at the same time

SAND-BLASTING HOOD

avoid any inconvenience owing to weight, impaired vision or difficult breathing.

The free admission of air is permitted by finely screened openings, while a glass partition of the front opening provides clear vision.

The helmet is a recent product of the Multi-Metal Separating Screen Co., 77 East 131st St., New York City.

Hand Miller with Weight Feed

In the hand miller shown the knee is of the box type, designed to provide rigidity and to afford protection to the vertical adjusting screw, thrust bearings and bevel gears. The lower end of the vertical adjusting screw is protected by the hollow upright part, which supports the vertical adjusting-screw nut.

Feed weights are provided to be hung on the handles shown.

The general design and construction of the machine are apparent from the illustration. The top of the table can be brought up on a level with the center of the

HAND MILLER WITH WEIGHT FEED

Dimension of table inside of oil pocket, 4x20 in.; dimension of table outside, 7x24 in.; adjustment of table under spindle, 15 in.; hole in spindle, No. 9 B. & S. taper.

spindle. The cone pulleys, 7 and 10 in. in diameter, provide four spindle speeds. The hand lever provides a table feed of 6 in., while the crank furnishes a 14-in. feed.

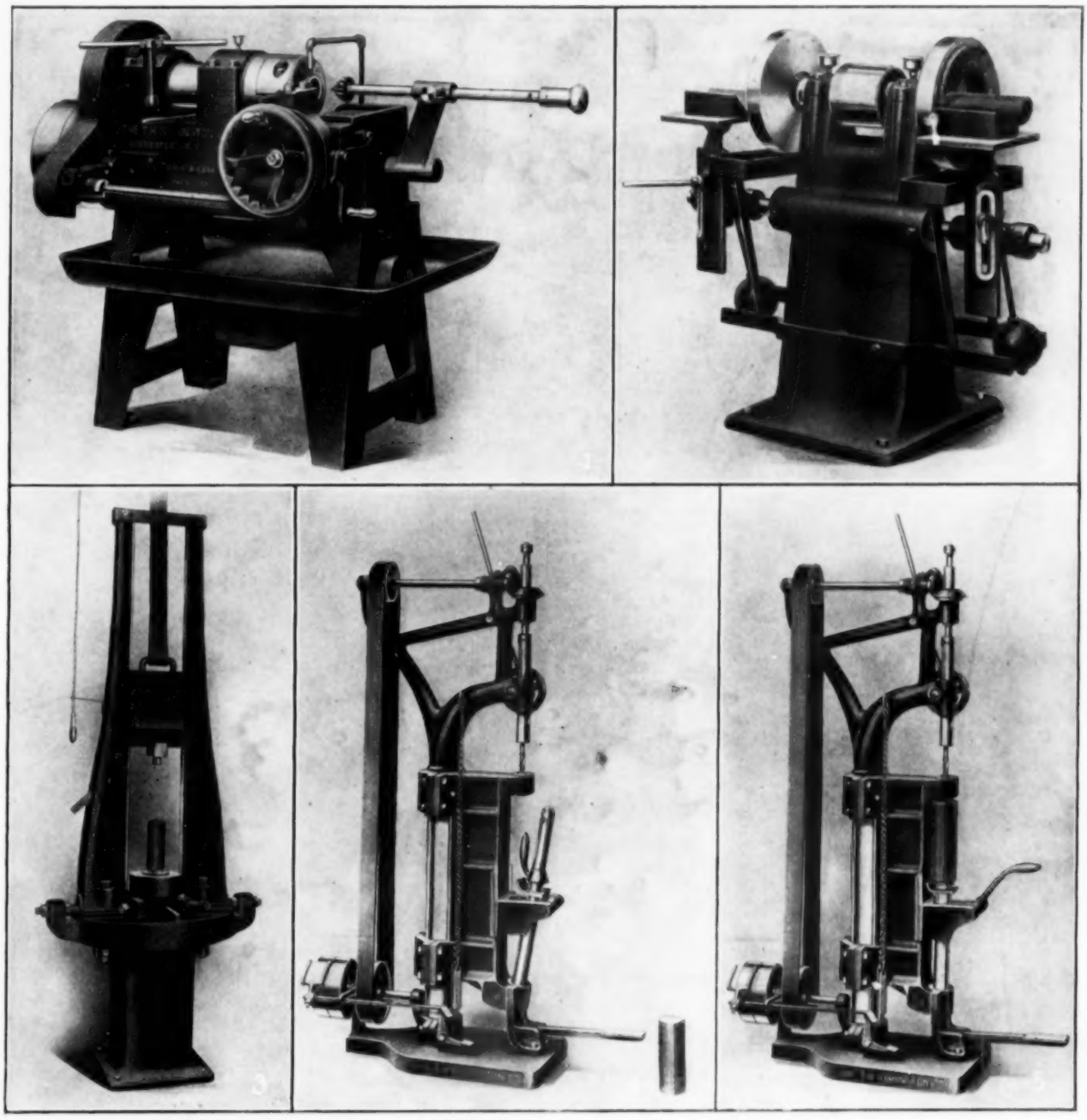
The machine is a late product of the Standard Engineering Works, Pawtucket, R. I.

Machinery for Shell Work

Among the interesting machinery developed for the manufacture of shrapnel and high-explosive shells is the line of special machines brought out by the T. H. Symington Co., Rochester, N. Y., who occupy a unique position on account of including a machine planned especially for each operation. This line of machines has been designed of well-known mechanical elements, with the sole purpose of having each machine perform its separate operation in the shortest possible time.

They are designed to carry through the operations on forged shells in the following sequence: Cut off the open end and take out the burrs caused by the cutting-off tool; grind the closed end square; nick the open end for driving center; center the closed end; first rough-turn; second rough-turn; bore and finish the inside of shell; rough-face the closed end or base; face the closed end; finish the base and rough out the band groove; put the undercut and wave in the band groove; bore, ream and tap the nose; finish-turn the outside of shell; turn the copper band.

As will be seen, the construction of the machines is simple, using large bearings, rigid holding chucks and well-supported cutting tools. Nothing has been spared to make the machine rigid, and nothing has been wasted in unnecessary finish.

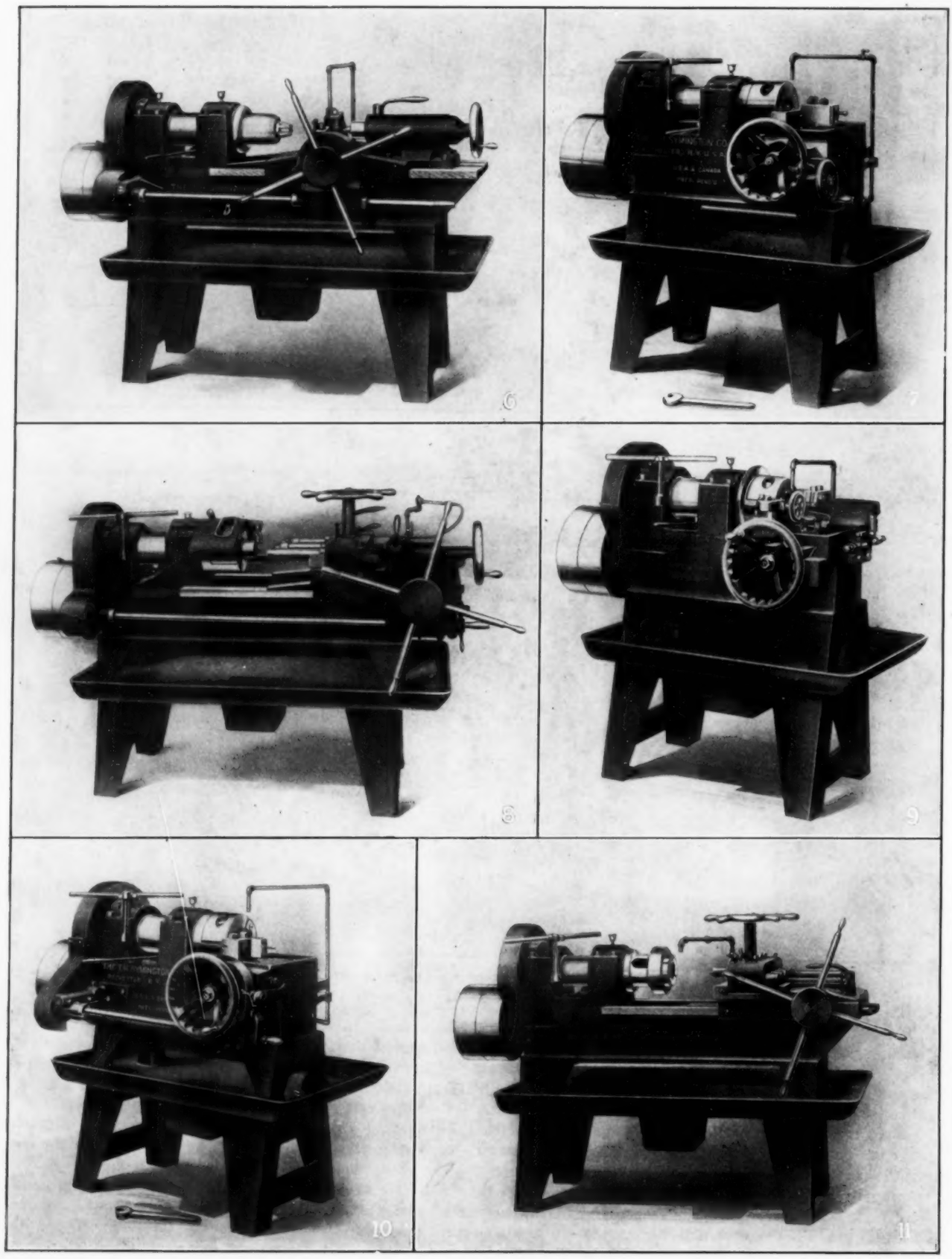


FIGS. 1 TO 5. SPECIAL SINGLE-PURPOSE MACHINES FOR SHELL OPERATIONS
Fig. 1—Chucking machine. Fig. 2—Ring-wheel grinder. Fig. 3—Drop-hammer. Figs. 4 and 5—Centering machine

The spindles of the lathe are of cast iron 6 in. in diameter, and both the front and rear bearings are 6 in. long. The spindles are ground so as to lay the iron in the direction it is to run in the bearing, and high-grade babbitt bearings are provided in all cases. The chucks form an integral part of the spindle, some being of the hinge or flap variety, while other are split and drawn together by a collar or sleeve. The machines are heavy, ranging in weight from 1,500 lb. for No. 1 to 2,100 lb. for No. 7. One interesting and time-saving fixture seen on all the machines is a wrench-holding bracket so placed that the operator need lose no time. It also eliminates excuses for mislaying the wrench.

Machine No. 1 grips the drop forging in the hinged chuck, which has three hardened jaws and holds the work easily in spite of inequalities of the forging. The cutting-off tool is ¼ in. wide by 2 in. deep and solidly supported, as can be seen. The cutting-off point is gaged from the bottom of the inside of the shell, the gage rod also supporting the burring tool, shown. This removes the burr left in cutting off. The closed end is next ground on a ring wheel, No. 2, so as to be square with the bore. The shells then go to the drop hammer, shown by No. 3, and the open end is placed over a burr containing chisels. A stroke of the hammer on the closed end produces ratchet-shaped nicks in the end of the shell. These nicks center the shell very accurately and afford a powerful drive for the outside turning operations, which follow.

The shell next goes to the centering machine, shown by Nos. 4 and 5, the tilting mandrel allowing it to be



FIGS. 6 TO 11. SPECIALIZED EQUIPMENT FOR SHELL-MACHINING OPERATIONS

Fig. 6—Rough-turning body machine. Fig. 7—Boring machine. Fig. 8—Rough-facing machine. Fig. 9—Base-forming and finishing machine. Fig. 10—Waving and undercutting machine. Fig. 11—Nose-forming and reaming machine

easily slipped into place. The mandrel has expanding jaws at the end, to center the closed end of the shell, while the cone lines up the open end. The tilting of this mandrel is controlled by the foot treadle, the handle just below the shell locking the mandrel into drilling position.

Turning comes next, the shell blanks being driven by the special spur on No. 6, which permits the tool to pass over the entire length of the shell. Two ¾-in. square turning tools are used, one at the front and the other behind. They are held in adjustable steel holders that are bolted to the lathe carriage. The front tool leads, and takes the heaviest cut, the second tool following about ⅛ in. behind. This makes it possible to hold the turning size within close limits.

Boring is done on machine No. 7, the boring tools being held in a very substantial cross-slide instead of the usual turret. The shell blank is gaged from the open end by a stop on the chuck guard and a spring plunger at the bottom of the hinged three-jawed chuck. The cross-slide carries three tools, the first for boring and the others for rough- and finish-reaming. One tool bar may be used for form boring, and in this case the cross-slide is guided by a hardened roll held against the steel cam, or form, by a heavy spring at the back of the machine. The heavy pressure required for finishing the bottom of the shell is accomplished by a powerful handwheel provided especially for this purpose.

The shell is then reversed in the three-jaw hinged chuck shown on No. 8, closed and rough-faced. The facing point is gaged from the bottom of the inside of the shell by a stop rod, which is fastened in the bottom of the chuck. As will be seen, the tool holder and cross-slide are rigid, a ¾-in. square turning tool being used.

Machine No. 9 is very similar, but has a different tool arrangement for finishing the base and also forming it. The blank is gaged as before, a ½-in. square tool being used for finishing and a small tool for roughing the band groove and finish-turning the base of the shell. A two-speed counter is used on this machine to give a slower speed for the form turning tool and a fast speed for facing the smaller diameter.

Waving and undercutting are done on machine No. 10, the waving tool being controlled by a cam direct on the lathe spindle, just behind the chuck. The undercut is secured by the form shown at the end of the bed, which gives a side movement as the tool is moved into the cut. The waving tool is supported at the back of the machine.

For forming and reaming the nose, machine No. 11, which closely resembles No. 7, is used. The shell is held in a four-jawed spring chuck, and provision is made for four bars in the cross-slide. It is rough- and finish-bored, tapped and undercut.

The finish-turning is done in the lathe shown in Fig. 12. The shell is held and faced by a four-jawed spring chuck, and at the nose by a quick-acting tail center, a centering plug being used in the shell. The tool is guided by a hardened pin that is held by a heavy spring against the steel cam, or form, at the back of the machine. An automatic quick-change speed device is provided to give a fine feed over the nose and bourrelet, and a passage over the body of the shell as far as the band groove.

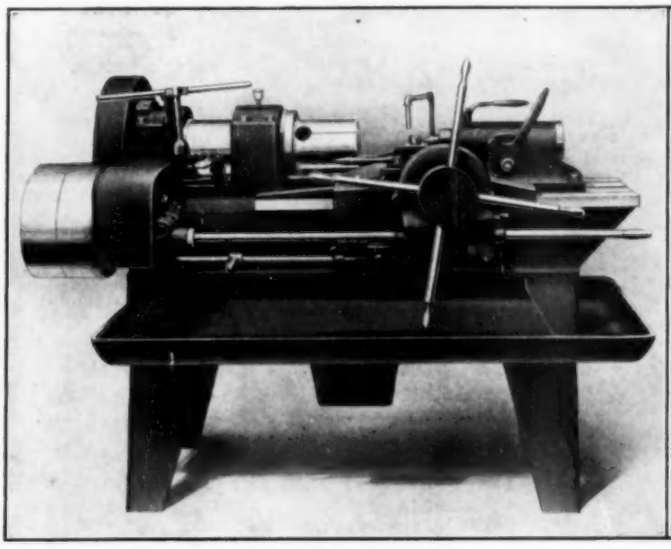


FIG. 12. FINISH-TURNING LATHE

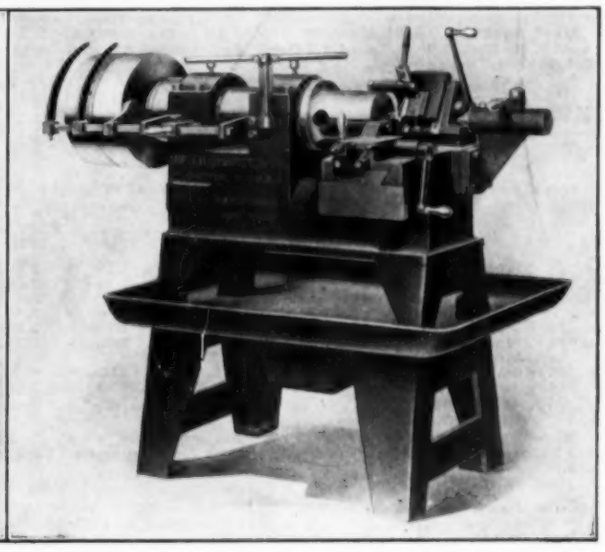


FIG. 13. BAND-TURNING MACHINE

After the copper band has been swaged in place, the shell goes to machine No. 13, where it is held by the base in a spring chuck and again supported as for finish-turning. A form tool is used at the front for rough-turning, and there is a shaving tool on the inclined slide at the back for the finish. A burring tool is also provided for scraping away the small fringe or sharp edge left by the finish tool.

On shells with curved noses a lathe with a split chuck is provided, the cross-slide carrying two tools of the desired form. Taken altogether, this group of machines makes a very complete set for handling all the various operations on the 3-in. shell. These machines are also made for larger projectiles, the spindles and other parts being proportionately heavier.

Personals

Leslie B. Stauffer, for many years associated with the Warner & Swasey Co., Cleveland, Ohio, has become secretary, succeeding Frank A. Scott, who was recently elected vice-president and treasurer.

Charles F. Scribner, a frequent contributor to the columns of the "American Machinist," until recently production engineer with the Colt's Patent Fire Arms Manufacturing Co., has become assistant superintendent of the Cleveland Twist Drill Co., Cleveland, Ohio.

Prices--Materials and Supplies

IRON AND STEEL

Pig Iron—Quotations were current as follows at the points and dates indicated:

	Feb. 4, 1916	Jan. 7, 1915	Feb. 5, 1915
No. 2 Southern foundry, Birmingham	$15.00	$15.00	$9.50
No. 2 X Northern foundry, New York	19.75	19.50	14.25
No. 2 Northern foundry, Chicago	18.50	18.50	13.00
Bessemer, Pittsburgh	21.45	21.95	14.55
Basic, Pittsburgh	18.70	18.95	13.45
No. 2 X, Philadelphia	20.00	19.75	14.25
No. 2, Valley	18.50	18.50	13.00
No. 2 Southern, Cincinnati	17.90	17.90	12.40
Basic, Eastern Pennsylvania	19.50	19.50	13.50
Gray forge, Pittsburgh	18.45	18.45	13.45

Steel Shapes—The following prices in cents per pound are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger from jobbers' warehouse, New York:

	Feb.4, 1916	Jan. 7, 1915	Feb. 5, 1915
Steel angles, base	2.60	2.50	1.85
Steel T's, base	2.65	2.55	1.90
Machinery steel (bessemer)	2.60	2.50	1.80

Steel Sheets—The following are the prices in cents per pound from jobbers' warehouse, New York:

	Feb. 4, 1916	Jan. 7, 1916	Feb. 5, 1915
No. 28 black	3.50	3.35	2.60
No. 26 black	3.40	3.25	2.50
Nos. 22 and 24 black	3.35	3.20	2.45
Nos. 18 and 20 block	3.30	3.15	2.40
No. 16 black	3.45	3.10	2.35
No. 14 black	3.35	3.00	2.25
No. 12 black	3.30	2.90	2.20
No. 28 galvanized	5.50	5.50	3.50
No. 26 galvanized	5.20	5.20	3.20
No. 24 galvanized	5.05	5.05	3.05

Swedish (Norway) Iron—This material sells at $4.50 base per 100 lb. f.o.b. New York. In coils an advance of 50c. is charged.

Cold Drawn Steel Shafting—From New York warehouse to consumers requiring fair-sized lots the price is 15% off list.

Bar Iron—Prices are as follows in cents per pound at the places named:

	Feb. 5, 1916	Jan. 6, 1916
Pittsburgh, mill	2.10	1.80@1.85
New York	2.20	2.00@2.07
From storehouse, New York	2.50	2.40@2.50

Standard Pipe—On carload lots f.o.b. Pittsburgh, the discounts follow:

	Black		Galvanized	
	Feb. 5, 1916	Feb. 5, 1915	Feb. 5, 1916	Feb. 5, 1915
¾- to 2-in. steel butt welded	76%	81%	60½%	72½%
2½- to 6-in. steel lap welded	75%	80%	59½%	72½%

At these discounts, the net prices in cents per ft. follow:

Diameter, In.				
⅜	2.76	2.20	4.54	3.15
1	4.08	3.24	6.72	4.67
1¼	5.44	4.38	9.09	6.30
1½	6.60	5.25	10.86	7.55
2	8.88	7.05	14.62	10.15
2¼	14.63	11.70	23.69	16.70
3	19.13	15.25	30.98	21.80
4	27.25	21.80	44.05	31.00
5	37.00	29.60	59.94	42.20
6	48.00	38.40	77.76	54.60

METALS

Old Metals—In New York, the following are the dealers' purchasing prices in cents per pound:

	Feb. 4, 1916	Feb. 5, 1915
Copper, heavy and crucible	21.00	12.10
Copper, heavy and wire	20.50	11.75
Copper, light and bottoms	17.50	10.50
Lead, heavy	5.00	3.20
Lead, tea	4.50	...
Brass, heavy	13.25	8.25
Brass, light	10.50	6.75
No. 1 yellow rod brass turnings	12.50	...
Zinc	12.00	4.50

Antimony—For spot delivery on Chinese and Japanese brands the quotation is at 42.50c. per lb., duty paid.

Miscellaneous Metals—The present New York quotations in cents per pound, with a comparison of practically a month and year ago, are as follows:

	Feb. 4, 1916	Jan. 7, 1916	Feb. 5, 1915
Copper, electrolytic (carload lots)	26.00*	24.00	14.75
Tin	41.75	41.00	37.00
Lead	6.10	5.90	3.70
Spelter	19.50	18.00	8.25
Copper sheets, base	32.00	30.00	19.25
Copper wire (carload lots)	32.00	30.00	15.25
Brass rods, base	38.00	35.00	14.75
Brass pipe, base	43.00	38.00	15.75
Brass sheets	38.00	35.00	15.50
Solder ½ and ½ (case lots)	26.00	26.50	24.50

ST. LOUIS

Lead ..... 5.95 Spelter 19.50

*This quotation is for delivery in June or later. For earlier delivery 27.50c. is asked.

Babbitt Metal—In New York, quotations are as follows in cents per pound:

Best grade	55@60
Commercial grade	25@30

Monel Metal—The following are the prices in cents per pound for mill lengths 8 ft. and over:

Size, In.	10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. and Over	Less Than 500 Lb. of a Size and Over
Rounds—Squares					
3/32 to 5/32	31.50	32.00	32.50	33.00	36.00
¼ to ⅜	31.25	31.75	32.25	32.75	35.75
⅜ to 1⅛	31.00	31.50	32.00	32.50	35.50
1⅛ to 2 7/16	31.75	32.25	32.75	33.25	36.25
Rounds					
3 to 3 7/16	32.50	33.00	33.50	36.00	37.00
Squares					
3	32.50	33.00	33.50	36.00	37.00
Rounds					
3½ to 3 13/16	32.25	32.75	33.25	35.75	36.75
Squares					
3 7/16 to 3 13/16	32.25	32.75	33.25	35.75	36.75
Rounds—Squares					
4 to 4 13/16	33.00	33.50	36.00	36.50	37.50
5 to 6 13/16	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ⅛ in. thick. Hexagon bars 2c. per lb. over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

SHOP ACCESSORIES

Carriage Bolts—On ⅜ by 6 in. and smaller 60 and 5% off list is allowed; for larger and longer sizes 50 and 5% off list is charged. For fair-sized orders from New York warehouse the following net prices at this rate would be charged:

Length, In.	Diameter ¼	5/16	⅜	7/16	½	⅝	¾
1½	$0.38	$0.53	$0.72	$1.05	....	....	....
2	.41	.58	.78	1.14	....	....	....
2½	.46	.62	.84	1.24	$1.54	$2.73	$4.04
3	.49	.67	.90	1.33	1.68	2.91	4.28
3½	.53	.71	.97	1.43	1.81	3.09	4.51

Machine Bolts—From New York warehouse, the base price for fair quantities are as follows: From ⅜ in. by 4 in. and smaller, 60 and 10% off list is discounted; for larger and longer sizes up to 1 in. by 30 in., 50 and 10% is allowed. At this rate prices per 100 are as follows:

Length, In.	Diameter ¼	⅜	½	¾	⅞	1 In.
1	$0.61	$0.86	$2.34	$3.47	$4.73	$6.80
2	.64	.92	2.51	3.71	5.04	7.20
2½	.67	.98	2.68	3.96	5.36	7.61
3	.70	1.04	2.85	4.21	5.67	8.01
3½	.73	1.09	3.02	4.46	5.99	8.42

Base prices on other sizes would be as follows: 1⅛ and 1¼ in. by 3 in. and up to 12 in. take 40% off list. On longer lengths a special pound price is quoted. For cold punched square nuts, 40% is discounted from list; for hot pressed hexagon nuts up to 1 in. by 30 in., 50%; up to 1 in. diameter, cold punched nuts, 40%. Buttonhead with hexagon nuts, 40% off list, as do hexagon head with hexagon nuts.

Bolt Ends with hot pressed nuts sell at the base price of 50 and 10% from list price. This is for fair-sized orders from New York warehouse.

Three-Inch Russian Shrapnel--IV*

By John H. Van Deventer

SYNOPSIS—The eight steps described in this article, which concludes the work on the 3-in. Russian shrapnel shell, are a combination of hand and machining operations. Of the latter the more important are the forming of the copper drive band, which is done without lubrication, and the file finishing of the nose of the shell. An unique and ingenious mechanical device used in revolving the shells while lacquering their exterior surfaces is described.

Anyone who has observed the combination of 4-ft. wrench and husky man power shown in operation 19, in which the fuse socket is screwed home into the shell, would consider that no force short of that exerted by the explosion of the shell itself would be sufficient to loosen the fuse socket. This fact does not influence the Russian ordnance officials, however, who insist on additional precaution in the shape of two 3/8-in. screws that extend through the steel shell into the metal of the fuse socket. The drilling and tapping for these screws, as well as for the "grub" screw that is to hold the zinc fuse-hole screw plug, is done on multi-spindle high-speed sensitive drills and is shown in operation sheet 23. The fixtures used in this operation consist of a stationary angle plate screwed to the drill table, represented at *A*, and a number of square index blocks, shown at *B*. These blocks are for the purpose of properly spacing the holes at 90 deg. of the shell circumference. They are clamped to the bases of the shells by means of the clamping screws, shown at *C*, which are tightened by means of a special socket wrench and which hold the split portion of the index block upon the base of the shell.

The stationary fixture *A*, while simple, is well adapted to fast production. There are three shell positions on this fixture, each located centrally with one of the three drill spindles. A detail of one of these shell positions is shown at the lower left-hand corner of the operation sheet. It consists of the central plug *H*, which enters and fits the hole in the fuse socket, and the distance plugs *J*, which butt up against the outside edge of the shell and maintain it at the proper distance from the face of the fixture.

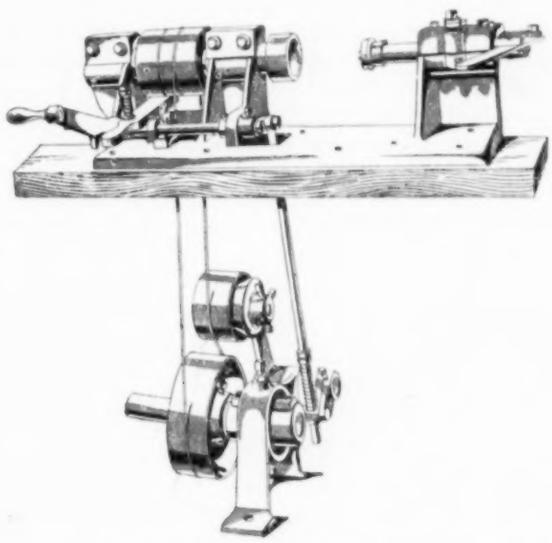


FIG. 1. BELT-DRIVEN SHELL FILING AND POLISHING MACHINE OF SIMPLE CONSTRUCTION

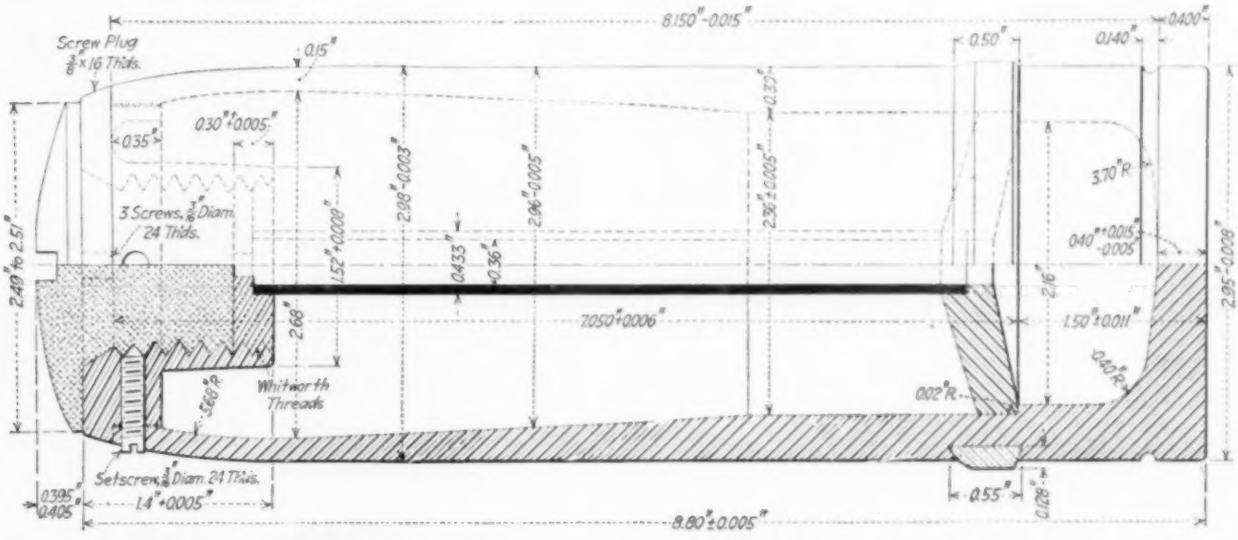


FIG. 2. SECTION THROUGH 3-IN. RUSSIAN SHRAPNEL, SHOWING DISK, POWDER-TUBE, FUSE SOCKET, COPPER PLUG AND ZINC FUSE-HOLE PLUG

The thrust of the drill is not taken altogether by plug *H*, but upon a strip that runs across the jig and upon one of the faces of the square index blocks.

The procedure in this operation is to spot a center with a countersinking drill, shown at *E*, through the bushing *D*. Then the shell is moved to the second position, in which the hole for the tap is drilled at *F*. Finally, the shell goes to the third position, in which these

*Previous installments appeared on pages 89, 155 and 177.

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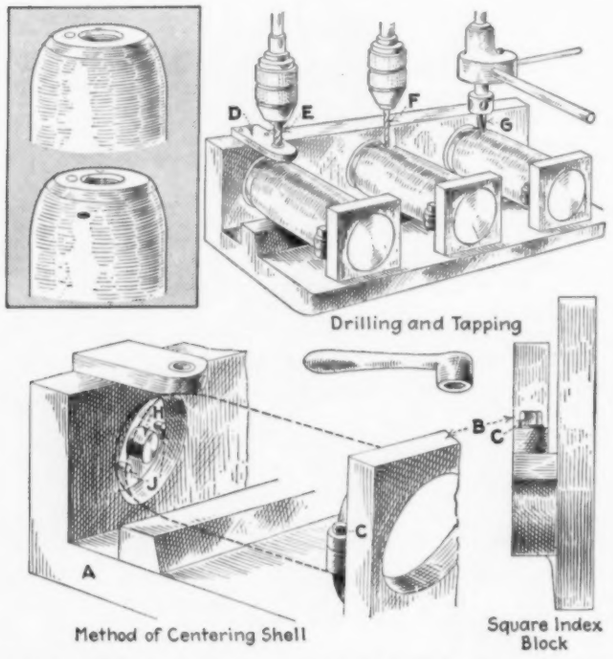
holes are tapped by the tap *G* in an automatic reversing tapping chuck. Three holes are drilled and tapped in each shell, with an average output of 30 shells per hr. This production is not at its maximum, since the capacity of the drills at this plant has exceeded that of the other machines.

The simple wooden vise shown at *A* in operation sheet 24 may well be applied to other examples of cylindrical work that it is desired to hold, and yet release quickly. It consists of a series of tapered wooden blocks forming spaces into which shells are dropped and where they are effectively held against rotation and other movement. While here, the ⅜-in. screws are driven home with a Yankee screwdriver, the heads are snipped off with a pair of hand shears and what is left of them is riveted over with a machinists' hammer.

A converted engine lathe furnishes the means of performing the double operation shown in operation sheet 25, in which the copper band is formed to size and shape,

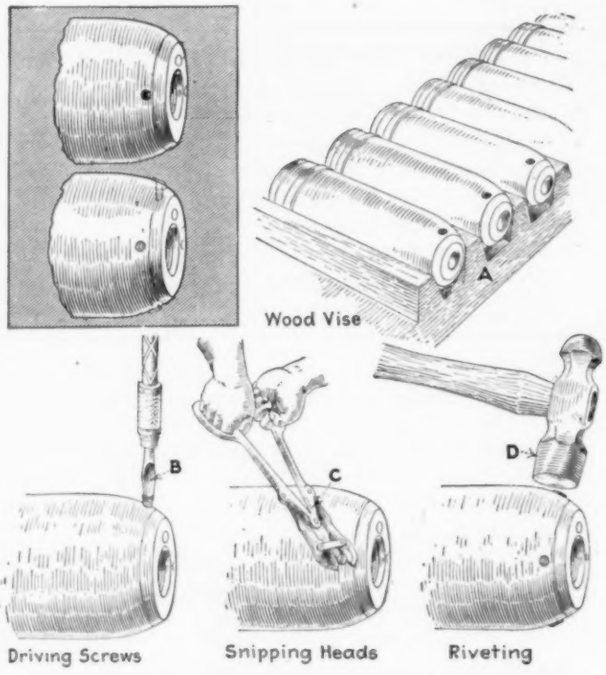


OPERATION 23: DRILL AND TAP FOR HOLDING SCREWS

Machines Used—Three-spindle sensitive drills.
Special Fixtures and Tools—Stationary centering fixture A; square index block B.
Gages—None.
Production—From one operator and one machine, 30 shells per hr.
Note—Speed for drilling and tapping, 1,200 r.p.m.; reversing tapping chuck used. Countersink with No. 11 and drill ⅞ in. for tapping; turpentine and white lead used as tap lubricant. Drills are run dry.

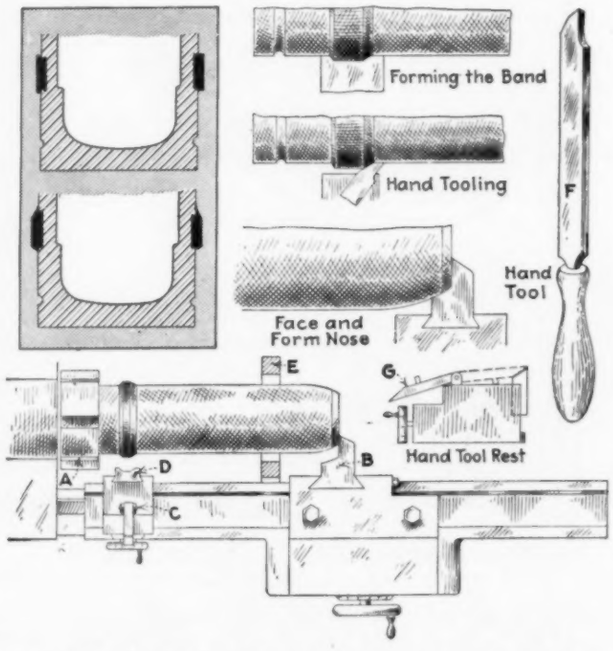
and the nose end of the shell is formed and faced. The shell is held in a simple split collet chuck, shown at *A*, and runs in the steadyrest *E*, with its outer end projecting beyond this so that the combination forming tool *B* may be advanced to face off the end of the fuse socket and also to remove the projecting ends of the riveted screwheads that remain from the preceding operation. An auxiliary tool slide is used for the copper-band forming. It is mounted on the lathe carriage at the proper distance away from the facing and forming tool *B* and is provided with a micrometer feed dial by means of which the size is determined.

A hand operation is necessary after the forming tool *B* completes its work, in order to remove the rough edges of the band. This tool is simply a flat file that has been dressed up on a grinding wheel to the shape shown at *F*. It is used in connection with the hinged hand-tool



OPERATION 24: INSERT HOLDING SCREWS, SNIP AND RIVET

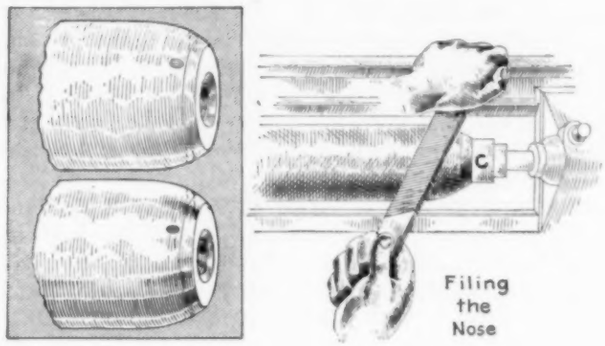
Machines Used—Hand operations.
Special Fixtures and Tools—Special wood-block bench vise A; Yankee screwdriver B; hand shears C; hammer D.
Gages—None.
Production—From three men, 2,500 shells in 10 hr.

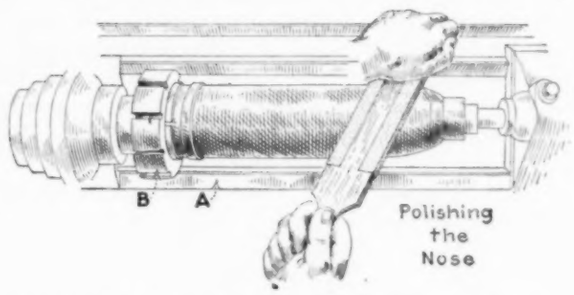


OPERATION 25: FORM DRIVE BAND, AND FACE AND FORM FUSE END OF SHELL

Machines Used—Converted engine lathes.
Special Fixtures and Tools—Split collet chuck A; nose-forming and end-facing tool B; auxiliary tool slide C, with band-forming tool D; steadyrest E; hand turning tool F.
Gages—Limit snap gages for diameter of copper band; templet gage for drive band; templet gage for nose profile.
Production—From one man and one machine, 30 to 40 shells per hr.
Note—No tool lubrication used in forming the copper drive band; cutting speed, 65 ft. per min.; sequence of operations—(1) form band, (2) hand-tool band, (3) face nose end and form.

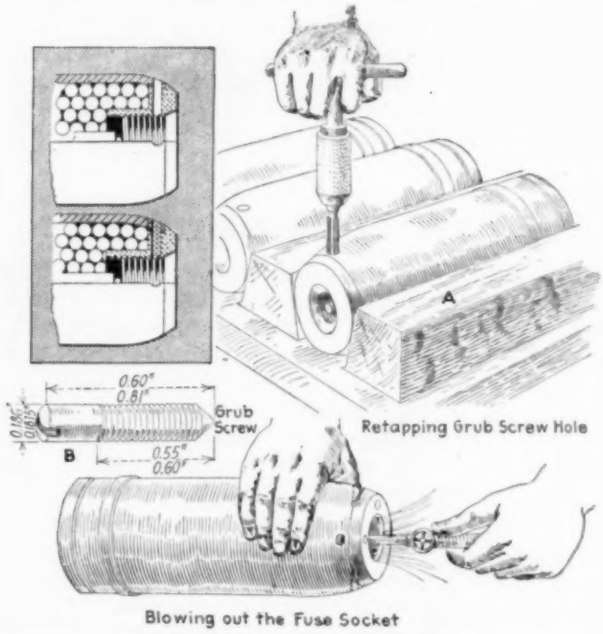
rest, shown at *G*, which is ordinarily flapped back out of the way except when hand-tooling, at which time it is brought into the position shown in the dotted lines and





OPERATION 26: FILE AND POLISH NOSE OF SHELL

Machines Used—Special polishing lathes, with cup chucks and ball-bearing, spring-actuated tail centers.
Special Fixtures and Tools—None.
Gages—Templet gage for nose profile.
Production—From one operator and one machine, 30 to 40 shells per hr.
Note—The polishing lathes used on this operation work in step with a like number of band-turning lathes, one of each, back to back, forming a unit.
Reference—Special polishing lathe, shown in Fig. 1.

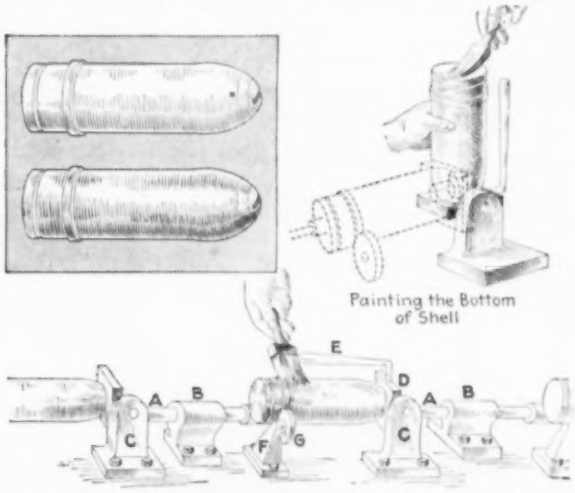


OPERATION 27: RETAP FOR FUSE-HOLE PLUG GRUB SCREW

Machines Used—None.
Special Fixtures and Tools—Wooden taper-wedge block vises A; hand tap.
Gages—None.
Production—Two men can handle 2,500 shells in 10 hr. on this operation.
Note—Compressed air used to blow out the fuse socket; the cork inserted in powder tube prior to operation 20 is now removed.

forms a tool rest. No lubricant is used in this operation, which is performed at a cutting speed of 65 ft. per min. with an output ranging between 30 and 40 shells per hr.

The same type of simple speed lathe that was used in the twelfth operation, shown on page 158, in filing and polishing the body and bourrelet of the shell is brought into use again in operation 26 for filing and polishing the nose. One of these lathes is placed back to back with each of the band-turning lathes, and the operators of each keep pace together, so that the two operations can really be looked upon as forming one unit. The chuck used, which is shown at *B*, is a simple cup chuck that grips the shell by friction and requires no tightening. The tailstock spindle is spring actuated and has a ball thrust bearing at *C*, similar to that shown in detail on the body-finishing lathe in operation 11 on page 158. These machines are run at a speed of 150 r.p.m. They are driven from below by means of a floor shaft and started



OPERATION 28: LACQUER OUTSIDE OF SHELL

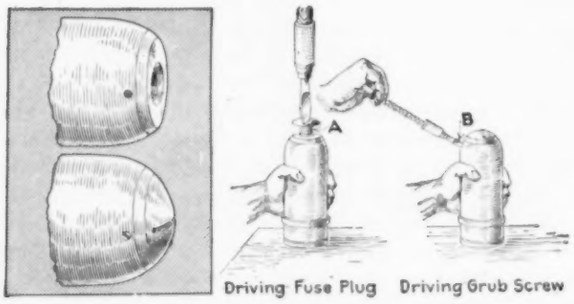
Machines Used—Special driving device mounted on bench and driven from floor shaft.
Special Fixtures and Tools—None.
Gages—None.
Production—Three men lacquer 2,500 shells in 10 hr.
Note—Shell is placed vertically on tipping block D, rotated by hand while the base is lacquered, then tipped horizontally and power driven by a leather friction wheel running on the copper driving band, while the cylindrical surface is lacquered.

and stopped by means of an idler pulley and an automatic brake, which is brought into action as soon as the belt tension is decreased. Lathes of this type are mounted upon a wooden base and are quite simple in construction, as shown by the one illustrated in Fig. 1.

It may have been noticed that but two of the three holes drilled and tapped in operation 23 were used for fuse-socket holding screws. In preparing the third hole for the fuse-hole socket grub screw that keeps the zinc plug from coming loose a retapping operation is necessary. It is shown in operation sheet 27. The shell is held in the tapered wood-block chuck, shown at *A*, while a hand tap is run through the threads to remove any burrs that may have been put on by the forming of the nose. At this time, also, the fuse socket is cleaned out with compressed air, and the cork that has remained in the powder tube since the twentieth operation is removed and returned to be used over again.

The final Government inspection and the stamping of the official marks upon the base of the shell have not been shown as operations, since they are really interruptions in the process of manufacture and not to be

considered as operations. If a shell manufacturer had his way about it, he would probably do away with both of them! Incidentally it may be said that the Russian final inspection is by no means a mere formality. By the time the shell has got past the two Government shop

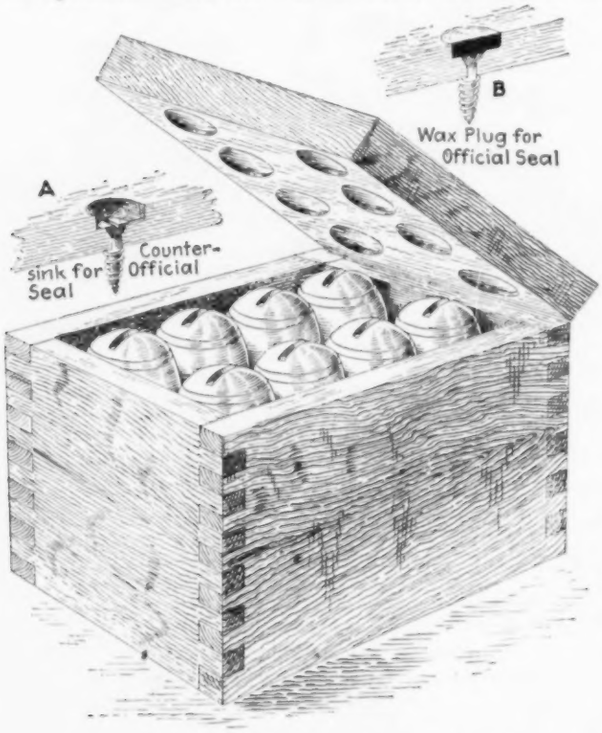


OPERATION 29: INSERT FUSE-HOLE PLUG AND GRUB SCREW

Machines Used—None.
Special Fixtures and Tools—None.
Gages—None.
Production—Two men produce 2,500 in 10 hr. on this operation.

inspections and the proving-ground test, if there is anything the matter with men, methods or machines at the factory, it has small chance of getting by without discovery.

An ingenious arrangement for painting shells is shown in operation sheet 28. It is about as effective an



OPERATION 30: PACK FOR SHIPMENT

Machines Used—None.
Special Fixtures and Tools—None.
Gages—None.
Production—Four men, 2,500 shells in 10 hr.
Note—After boxing, the cover is sealed by means of a countersunk wax plug, shown at A and B.

arrangement has has yet been developed by the shell manufacturers. The device is mounted on top of a work bench and consists of a drive shaft *A* running in bearing *B* and provided with leather friction drivers at various points in its length. The shells are held on swivel stands, consisting of brackets, shown at *C*, and tipping blocks *D*, which are manipulated by means of the handle *E*. The bottom of the shell is first painted while in a vertical position, the shell being rotated by hand, after which it is tipped over against the leather friction driver and the idler *G*, which runs upon the copper band, and the painting of the outside is completed. The shell is held at its nose, or fuse, end upon the tipping block by means of a plug that fits within the hole in the fuse socket and permits the shell to rotate.

Zinc is getting to be rather an expensive metal, and those who have subcontracts for Russian shrapnel are glad that they do not have to pay for the zinc fuse-hole screw plugs that are used to close the shell for shipment. One of these is shown being screwed home at *A* in operation sheet 29. There is quite a contrast between the zinc plug and the wooden fuse-hole screw plug, which was described and illustrated in *American Machinist*, Vol. 43, page 1057. This difference is multiplied enormously by the quantities in which they are used, and the total must represent an amount that would be well worth saving by the use of cheaper material.

After the fuse-hole screw plug has been driven home, it is held by means of the setscrew inserted in the small $\frac{5}{32}$-in. hole, the pointed end of which bears against the thread of the screw. Russian shells of this size are shipped eight in a box in substantial wooden packing cases made with locked corners. One of these is shown in operation sheet 30.

An interesting point is the manner of sealing these boxes so that when received on the other side there will be assurance that they have not been tampered with. At *A* is shown a counterbore through which one of the cover screws is drilled and countersunk. There are two of these counterbored holes in each cover in addition to the other screws, which are flush with the top surface. Wax plugs are inserted in these counterbores after the screws have been driven home. The plugs are heated by means of a gasoline blow torch and then sealed by the official receiver of the goods after the case has been packed.

Plan for Industrial Research

Following a personal study of industrial conditions in Germany and other foreign countries by Dean Frederick A. Goetze and several members of the faculty of the Graduate Engineering School of Columbia University, Dean Goetze elaborates in his annual report, which has just been issued, the proposed plans for the foundation of a large industrial-engineering research laboratory under the auspices of the university. Such a move, he sets forth, would be a boon to the industries of this country, bringing to their aid, as is done in Germany, keen university research study to solve the many engineering problems which confront them and saving them millions of dollars.

The plan outlined by Dean Goetze and his colleagues calls for the immediate erection of a building easily accessible to the university, with water and railroad facilities, which with the equipment necessary would cost $500,000. This would be but an initial step, however, as it is ultimately proposed that a research foundation of from $2,000,000 to $5,000,000 be secured, the income to be used exclusively for engineering research.

Painting Small-Shop Products--III

By John H. Van Deventer

SYNOPSIS—While brush painting is the most common process of finishing small-shop products, dip-tank finishing should be studied. It is within the reach of the average small shop and saves labor. The use of dip tanks is described in this article, which also touches on oven drying, spraying, and tumbling.

Dip-tank finishing is a subject that the small-shop man needs to know more about. Paint, primer, filler, enamel, japan and varnish can be dipped, although there are limitations coming from a design of the piece; but where this process can be employed, it not only saves labor, but is likely to give smoother results.

Work that contains holes or recesses from which the accumulated paint will drip upon other surfaces is not suitable for dipping. An example of this is shown in Fig. 1 at *A*, in which the cast-iron stove plate has a number of central depressions. If it is dipped and then allowed to drain, drops will run down from these holes, and the result will be a smear. Of course, it is possible to touch up such spots with a brush, but this takes away the low labor-cost advantage of dipping. It is much better to design the piece with this point in mind and thus overcome the difficulty without cost.

Sometimes work that cannot be dipped successfully in one position may be made to turn out all right by using a little commonsense. An example of this is shown in Fig. 1 at *B* and *C*. Here is a steel plate having an opening, not at the center, but near one edge. If it is held and dipped in the position shown at *B*, the result will be even worse than in the foregoing case; but by turning this piece around, as shown at *C*, one stroke of the brush will remove the drip between the recess and the edge of the plate.

In addition to the restrictions coming from the design or shape of the piece there are certain points to consider about the color to be used. Black, bright red and blue are good dipping colors; but olive green is a bad one, because it is composed of different pigments, which have a tendency to separate in the tank and give streaky effects.

Small-shop products are not, as a rule, large or complicated. Dipping tanks are so easily made that there is no excuse for their not being suitable for the work. A good dip tank has the least area of its contents exposed to evaporation and also contains a minimum quantity of paint. The evaporation from the surface of a dip tank causes considerable loss of material and also of time in keeping the solution at its proper consistency. A flat piece, for example, may be dipped either in a shallow tank, as shown at *B* in Fig. 2, or in a deep, narrow tank, as shown at *C*. The first way would be expensive in paint; although the first cost of the tank would be less, evaporation and waste would soon make up for this. Steel window sashes are dipped on this principle in tanks that are 6 to 10 ft. deep and only a few inches wide.

When a tank is designed to present the least surface area, it follows that the minimum amount of paint for successfully operating the tank is also reduced in proportion. Thus these two principles of good design for dip tanks are both obtained by simply trying to live up to one of them.

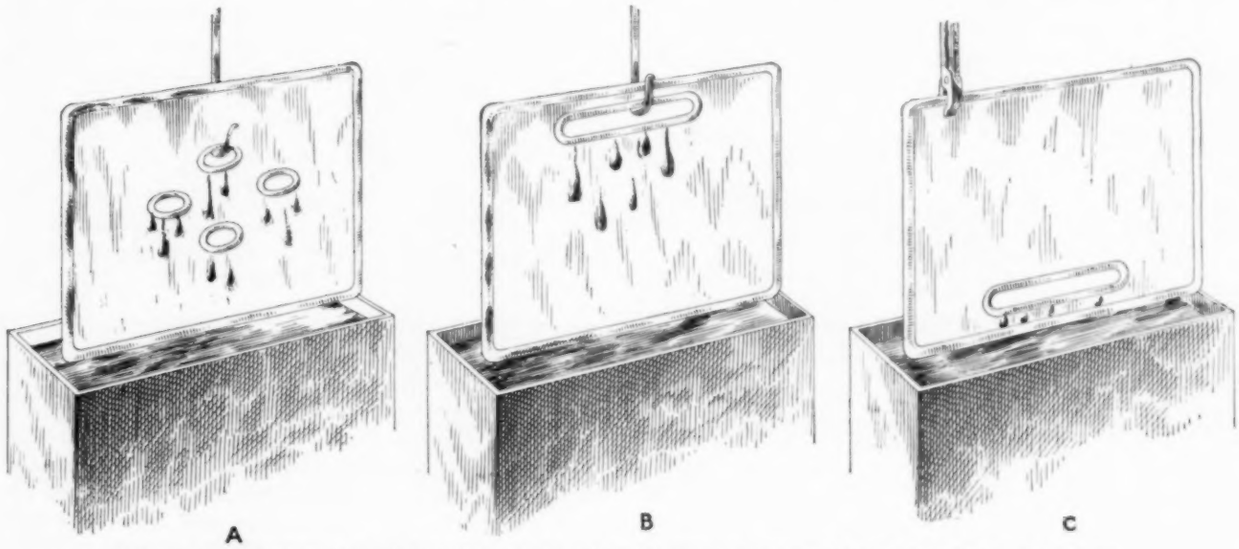


FIG. 1. THE SHAPE OF THE PIECE AND THE WAY IT IS DIPPED ARE IMPORTANT FACTORS

Many small-shop products may be dipped in tanks that are no larger than ordinary cooking utensils or paint pails. Such small pieces are dipped by hand, then placed on one edge on boards to dry. When the pieces become larger, mechanical handling is necessary. This fact restricts the process on large work to shops in which the production is great enough to call for the equipment and room required. An overhead monorail trolley is usually found in such a dip-finishing room. It is broken over the tanks, the short broken section being provided with means for raising and lowering, so that the piece may be run onto this section, be dipped, raised again and run off without undue loss of time. After dipping, it must be allowed to drain, so that the surplus paint, which is worth saving, comes back to the tank.

Some automobile manufacturers paint their wheels by dipping, then get rid of the surplus paint by rotating them. Centrifugal force throws the paint back into the tank. Such complicated apparatus is out of the question for the small shop, but the centrifugal principle may be applied on smaller pieces without much elaborate machinery, and with good results. It is a thing that is worth remembering.

One of the problems in connection with dipping is to keep paint from getting where it is not wanted. This requirement restricts the use of the dip process, especially on work that has a number of finished surfaces or holes. There are ways of getting around this point. Whether it is economical to use these expedients or not depends upon whether the time needed for using them plus the time of dipping will be less than the time of brushing.

Wooden plugs are often used to keep paint out of holes. Melted paraffin run over finished surfaces will keep them free from paint, but it must be removed by heating the article after the paint is dry. This scheme can be used only with air-drying paints, for if parts with

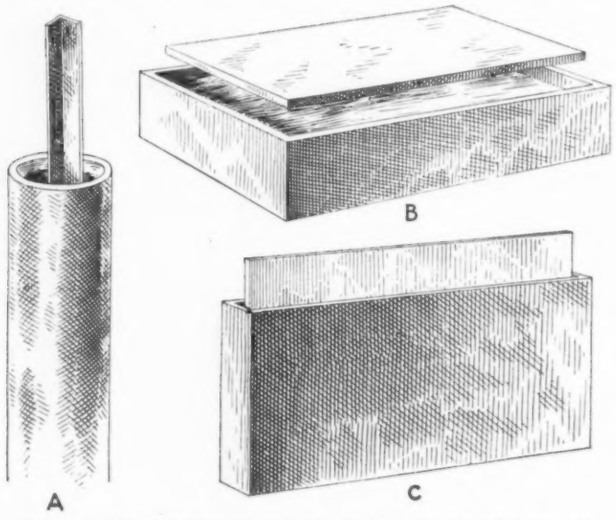


FIG. 2. THE DIPPING TANK MUST BE DESIGNED ON DEFINITE LINES

paraffined surfaces were put into an enameling oven, the wax would melt and run down and form a new and undesirable kind of finish. Hollow work, on which it is desired to keep paint from the interior, may be dipped with a closed end down, not being entirely submerged. After the piece is withdrawn from the dip tank, it is turned end for end so that the drip is downward toward the unpainted end, which is covered by a few strokes of the brush. There are hundreds of such expedients that may be used and that require only a little ingenuity and planning in advance.

A kink in connection with dipping has to do with obtaining a tag that will go through the dip tank without having its characters obscured by the paint. This problem presented difficulty to a manufacturer of small hand pumps and resulted in loss of time, because it was necessary for the man at the tank to remove each tag and fasten it on again after dipping. This trouble was overcome by the means shown in Fig. 3, which represents the product of a stencil-cutting machine. There is nothing about such a tag to become obscured in the dip.

The difference between air and oven drying is only a question of the degree of heat and the length of time required. No doubt, an enamel finish-dried in the air for several months would be as hard to remove from the surface on which it was put as one that had been baked for a few hours in a drying oven. Ovens are therefore a means of hastening the process of securing a hard, durable finish. They are not complicated, and the temperatures do not run very high, 600 deg. F. being about the limit. As far as the small shop is concerned, there is nothing complicated about the process of baking enamel or japan. The only question is whether the quantity of pieces is sufficient to warrant the expense of the labor of handling them back and forth from the ovens.

Black japan, which one finds on typewriters, business phonographs, adding machines and a similar class of work, is one of the most durable and oil-resisting finishes that can be put upon metal. The finish secured with it varies from the plain two-coat finish for small and cheap articles to the seven and ten coats used on the higher-grade machines. On this fine class of work, each coat after being baked is sanded, or rubbed with pumice, and often on work that has been stripped or gilded a protecting coat or coats of varnish are applied and baked.

Japan finish is always black, but colors are obtained by the use of enamels that are baked in the same way. The number of coats for enamel finish varies with the quality of the work, but a very respectable job can be obtained with two coats. I recently saw a test piece

FIG. 3. PERFORATED TAGS ARE NOT DEFACED IN DIPPING

finished in two coats of enamel of ordinary quality. It had been submersed in kerosene oil for two years and showed no signs of softening.

Spraying is an ideal method of putting paint upon most surfaces, large or small. In small shops the lack of compressed air usually settles the matter at once and decisively. There are certain shops, however, which are small and yet have air compressors, and there are others in which the present method of finishing products would make it a paying proposition to install a small compressor such as is required for this class of work. Pressures as low as 14 lb. to the square inch are used, and as high as 80, painting, of course, going more quickly with the higher pressure. Filler, color and varnish can all be sprayed, but the consistency must be fixed so that the nozzle does not clog and paint does not run in waves on the work. It does not pay to spray work in which a large part is composed of open spaces—for example, bicycle wheels and wire.

Tumbling is suitable for small work that is to be japanned, where the quantities contained in the batch may vary from five hundred to fifty thousand pieces. Shoe buttons are an excellent example of this class of work, which it would be difficult to coat evenly, uniformly and as cheaply by any other method. After being tumbled for a certain length of time in connection with an amount of japan sufficient for the batch, the contents of the tumbling barrel are put on wire-mesh screens and baked in an oven. A number of coats are applied in this way.

Tool Steels for Quantity Production

By Charles F. Scribner

What steel to use for certain tools in these days of demand for large-quantity production is perhaps one of the most difficult problems for the production manager to solve. Especially is this so in concerns engaged in the production of "war munitions," where quick deliveries and quality of product must necessarily be combined.

The information herewith is based on the practice of a concern that has studied this matter extensively and shows the standard practice in the matter of tools for firearms components. Its value at this time will be especially appreciated by those who may have, or who contemplate taking on, contracts along this line.

TABLE 1. CLASSES AND BRANDS OF STEELS USED FOR DIFFERENT TOOLS

Name of Tool	Steel Used
Drills ½ in. and smaller	High-speed drill rod
Drills over ½ in.	Novo Superior
Reamers ½ in. and smaller	High-speed drill rod
Reamers over ½ in.	Novo Superior
Reamers long in proportion to diameter	Ketos oil-hardening
Counterbores ½ in. and smaller	High-speed drill rod
Counterbores over ½ in.	Novo Superior
Butt mills ½ in. and smaller	High-speed drill rod
Butt mills over ½ in.	Novo Superior
Taps ½ in. and smaller	High-speed drill rod
Taps over ½ in.	Novo Superior
Taps having fine threads	Super-Rapid White Label
Thread dies	Novo Superior
Thread dies having fine threads	Super-Rapid White Label
Chamber reamers for barrel	Super-Rapid White Label
Slotting tools ½ in. and smaller, used in holders	High-speed drill rod
Slotting tools with square shank to fit holder	Novo Superior
Forming tools for screw machine	Novo Superior
Cutting-off tools	Novo Superior
Broaches	Novo Superior
Milling cutters	Novo
Thread-milling cutters for coarse threads	Novo Superior
Thread-milling cutters for fine threads	Super-Rapid White Label
Profiling cutters	Novo
Saws	Novo (sheet)
Blanking dies	Novo
Drawing dies	Firth's Best Tool
Cold-trimming dies	Novo
Hot-trimming dies	Novo
Drawing punches	Chrome nickel
Heading punches	Chrome nickel
Standard drill bushings	Styrian Gold Label
Special drill bushings	Ketos oil-hardening
Standard locating plugs	Styrian Gold Label
Special locating plugs	Ketos oil-hardening
Filing jigs	Ketos oil-hardening
Small tools of intricate form	Ketos oil-hardening
Wood-cutting tools	Novo Superior

TABLE 2. LIST AND DESCRIPTION OF TOOL STEELS USED IN MODERN PRACTICE

Carbon Steels:	
Crescent Extra	1.05 to 1.15 per cent. carbon
Firth's Best Tool	1.05 to 1.15 per cent. carbon
Rose Label Styrian	1.10 to 1.20 per cent. carbon
Hobson's Choice	1.25 to 1.40 per cent. carbon
Alloy Steels:	
Chrome nickel	Chrome-nickel alloy
Ketos	Manganese alloy
Gold Label Styrian	3½ per cent. tungsten alloy
Firth's R. T.	3½ per cent. tungsten alloy
Champion Double Special	7 per cent. tungsten alloy
High-speed Steels:	
Novo	Chrome-tungsten alloy
Novo (sheet)	Chrome-tungsten alloy
High-speed drill rod	Chrome-tungsten alloy
Novo Superior	Chrome-tungsten alloy
Blue Chip Superior	Chrome-tungsten-vanadium alloy
Super-Rapid White Label	Chrome-tungsten-vanadium alloy

Carbon-Tool Steels—Crescent Extra and Firth's Best Tool steels are domestic steels of good quality and can be used for general all-around work. These steels will machine readily, if properly annealed, and harden best when heated to about 1,400 deg. F. and quenched in water.

Alloy Tool Steels—Chrome-nickel steel is made containing various amounts of carbon. Those containing the lower amounts of carbon (about 0.50 per cent.) are suitable for crankshafts and general automobile construction. Those containing the higher amounts of carbon (about 0.80 per cent.) are suitable for use in tools. This steel is very dense, tough and hard and will stand shock well. It hardens best when heated to about 1,450 deg. F. and is quenched in oil. Ketos oil-hardening is a domestic steel and is called non-shrinking and non-warping. It is very tough and hard and can be used for work that must not change in the hardening process. This steel hardens best when heated to 1,360 deg. F. and quenched in oil. Gold Label Styrian is an imported steel and has been found to hold a fine edge and put a fine finish on the work. It is hard and dense in structure. This steel can be used for tools that require an extremely hard surface or fine edge. It hardens best by heating to about 1,475 deg. F. and quenching in water. Firth's R. T. is a domestic steel similar in characteristics to Gold Label Styrian steel. Champion Double Special is also a domestic steel and has been found to be harder and more dense than Gold Label Styrian and is consequently better adapted for use under certain conditions.

High-Speed Steels—Novo and Novo sheet steel are imported steels and are capable, in the main, of being used at high speeds. They last well without sharpening. These steels can be used for all roughing tools and, under certain conditions, for finishing tools as well. In their normal state they are extremely hard and dense, hardening being accomplished by heating to from 2,100 to 2,200 deg. F. and quenching in oil or an air blast. Novo Superior is an imported steel similar to the two just mentioned, except that it will hold a keen edge longer than Novo. This steel can be used for finishing tools where only the very best is required. It is preferably hardened by heating to from 2,100 to 2,200 deg. F. and quenching in oil or water. Blue Chip Superior is a domestic steel of similar characteristics to Novo Superior and gives equal satisfaction in use. This steel is best hardened by heating to from 2,200 to 2,300 deg. F. and quenching in oil or water. Super-Rapid White Label is an imported steel, similar to the two last named. It hardens at a much lower heat, about 1,900 deg. F., which is an advantage in the construction of many tools.

TABLE 3. TOOLS FOR VARIOUS CLASSES OF WORK MADE FROM DIFFERENT STEELS

Steel Used	Tools Used For
Chrome nickel	Drawing punches, heading punches
Ketos oil-hardening	Filing jigs, special drill bushings, special locating plugs, small tools of intricate form, reamers long in relation to their diameter
Gold Label Styrian	All fine tools
Firth's R. T.	Drawing dies
Champion Double Special	Medium and large drills, medium and large reamers, standard drill bushings
Novo and Novo (sheet)	Milling cutters, profiling cutters, saws, blanking dies, cold-trimming dies, hot-trimming dies
Novo Superior	Medium and large taps
Blue Chip Superior	Threading dies
Super-Rapid White Label	Medium and large counterbores slotting tools, cutting-off tools, forming tools, chamber reamers, special drills, special reamers, broaches
High-speed drill rod	Small drills, small counterbores, small reamers small taps

Alloy and high-speed steels can be used for nearly all tools for the manufacture of firearm components with greater efficiency than carbon steels. They cannot, however, be welded in the blacksmith's ordinary fire, but must be either brazed or welded by the oxyacetylene flame. Novo sheet steel, cold-rolled, can be obtained in thicknesses of from 0.020 to 0.133 in. High-speed drill rod can be obtained in sizes from 0.0625 to 0.500 in. inclusive.

Table 3 will serve as a cross-reference to Table 1, as it lists the various classes of tools that can be most efficiently made of the various grades of steel already mentioned.

Machining Connecting-Rods

By Robert Mawson

SYNOPSIS—Details of jigs, fixtures and tools for milling, drilling, boring and reaming connecting-rods for an eight V-motor.

The small tools, operations and methods used in machining some of the parts of the automobile eight V-motor manufactured by the Ferro Foundry and Machine Co., Cleveland, Ohio, have been described on pages 14, 98 and 186. This article is the fourth of the series and shows the small tools and methods used for the connecting-rods, one of which is shown in Fig. 11. The jigs and fixtures used are representative of uptodate automobile small-tool design embodying time-saving devices.

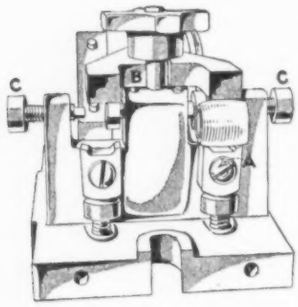


FIG. 2

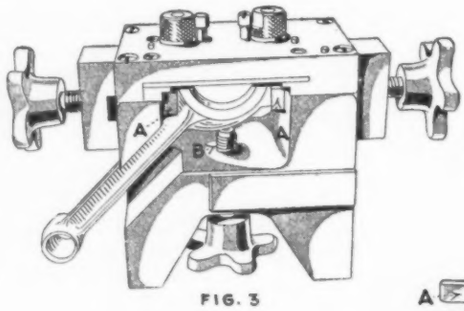


FIG. 3

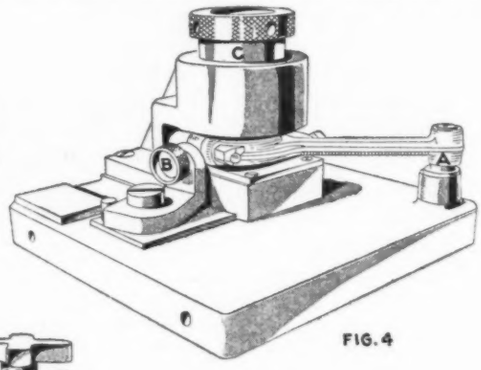


FIG. 4

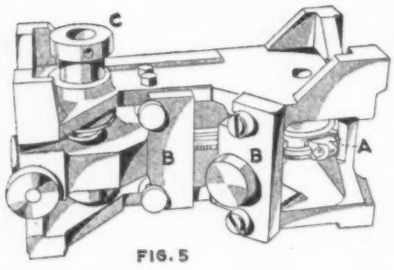


FIG. 5

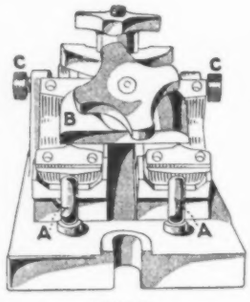


FIG. 7

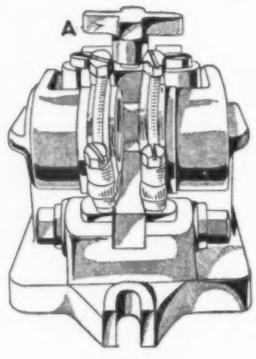


FIG. 8

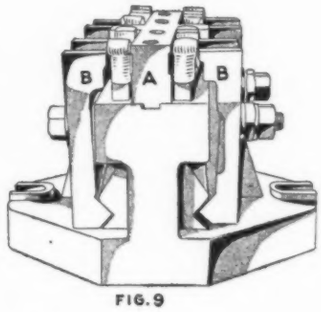


FIG. 9

JIGS AND FIXTURES FOR MACHINING CONNECTING-RODS, WITH WORK IN POSITION

FIGS. 2 AND 2-A

Operation—Straddle-milling wristpin end of connecting-rod, Fig. 1. The forging is located in pins at the large end in holes previously machined and rests on tool-steel V-blocks A. Strap B is tightened down with a knob nut and the knurled-head screws C hold the parts securely.

Surface Machined—Wristpin bosses, with a gang of cutters 5 in. in diameter by ¾ in. thick, suitably spaced. Speed, 38 r.p.m.; feed, 0.032 in. per revolution.

FIGS. 3 AND 3-A

Operation—Drilling and tapping bolt holes in connecting-rod. The forging is located by V-blocks A, operated by knob screws and held against the steel strip with screw B.

Holes Machined—Two ¼-in. holes drilled and $\frac{5}{16}$-in. 24 U. S. F. threads tapped for screws to hold cap on the connecting-rod.

FIGS. 4 AND 4-A

Operation—Boring and reaming large hole in connecting-rod. The forging is located on pin A, fitting in the reamed wristpin hole, and is forced back against the stop with knurled-head screw B.

Hole Machined—2.115-in. hole, bored and reamed, using slip bushings at C.

FIGS. 5 AND 5-A

Operation—Drilling and reaming wristpin hole and oil hole in connecting-rod. The forging is located on two pins at end A and forced against stopscrews with knurled-head screws in the shaft B.

Hole Machined—⅞-in. hole, drilled and reamed, using slip bushings C in jig and ½-in. oil hole in end of rod.

FIGS. 7 AND 7-A

Operation—Milling recess for joint on connecting-rod fork for gang. The rough-forging is located on hardened-steel blocks at the rear and resting on steel pins A at the front. The strap B and knurled-head screws C hold the forgings securely.

Surface Machined—Recess and parting line, using gang cutters consisting of two 4x½-in. and two 3¾x¾-in., suitably spaced. Speed, 46 r.p.m.; feed, 0.06 in. per revolution.

FIGS. 8 AND 8-A

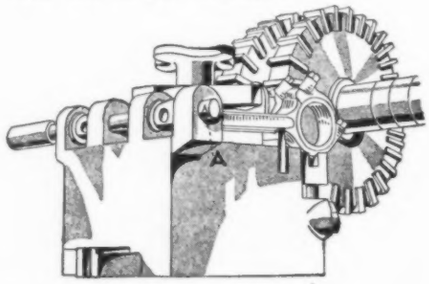
Operation—Milling out metal to form fork end of connecting-rod. The forging is located by a pin fitted in the reamed wristpin hole and resting on height pins in front; it is held down with screw A through the strap.

Surface Machined—Inside fork slot, using 6x¾-in. inserted-tooth cutter. Speed, 32 r.p.m.; feed, 0.05 in. per revolution.

FIGS. 9 AND 9-A

Operation—Milling joint surfaces on caps for connecting-rod forgings, located on steel blocks and held against the hardened-steel blocks A with straps B.

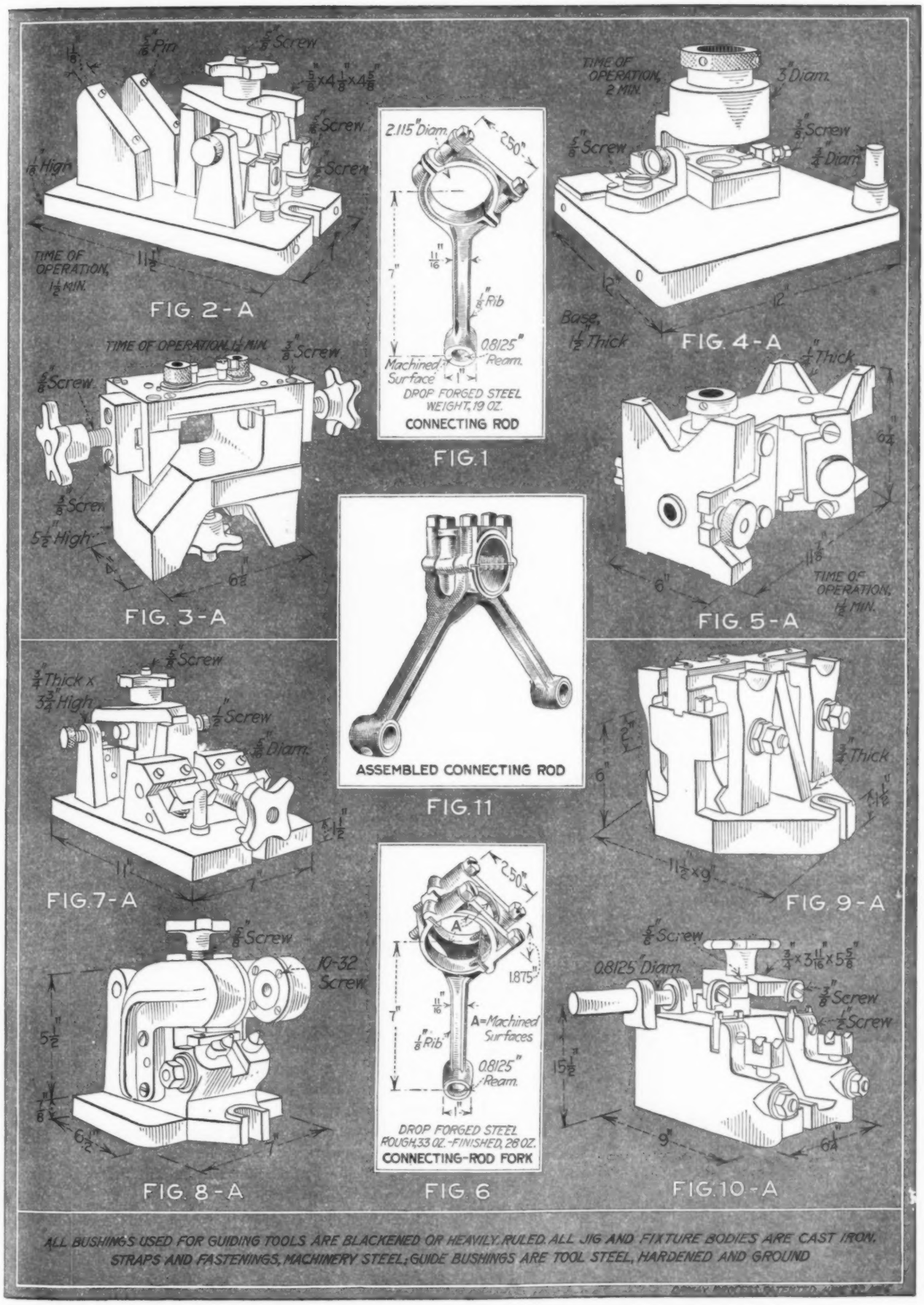
Surfaces Machined—Joint and register, using gang cutters consisting of 4x½-in. and 3⅝x¾-in., suitably spaced. Speed, 46 r.p.m.; feed, 0.06 in. per revolution.



FIGS. 10 AND 10-A

Operation—Straddle-milling the large end of the connecting-rod fork. The forging is located by pin A, which fits in the wristpin hole previously reamed and rests on hardened-steel locating blocks. The strap, when tightened down, holds two forgings.

Surface Machined—Both sides of the large end of the rod. Gang cutters, 10x1¼ in. wide; inserted cutters suitably spaced. Speed, 17 r.p.m.; feed, 0.06 in. per revolution.



DETAILS OF JIGS AND FIXTURES USED IN MACHINING 8 V-MOTOR CONNECTING-RODS

Milling an Internal Keyway

The method of milling an internal keyway in an automobile brake support is shown in Fig. 1. The brake support and the position of the keyway cut are shown in detail in Fig. 2. One of the supports is also shown in the foreground

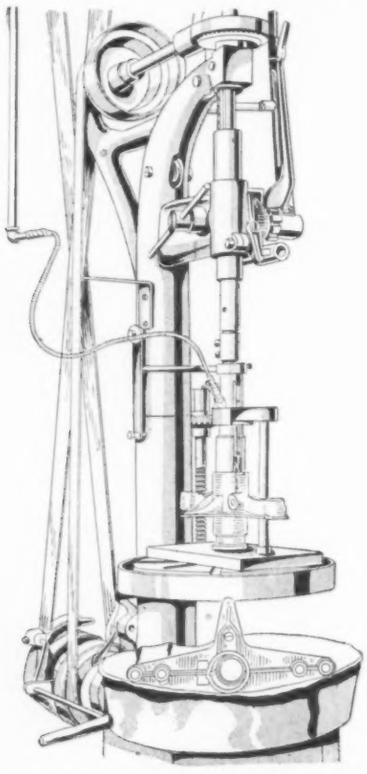


FIG. 1. MILLING AN INTERNAL KEYWAY

just below the drilling-machine table. The method of holding the work in the jig is plainly shown.

The tool used to cut the keyway is a regular internal keyseater made by the National Machine Tool Co., Cin-

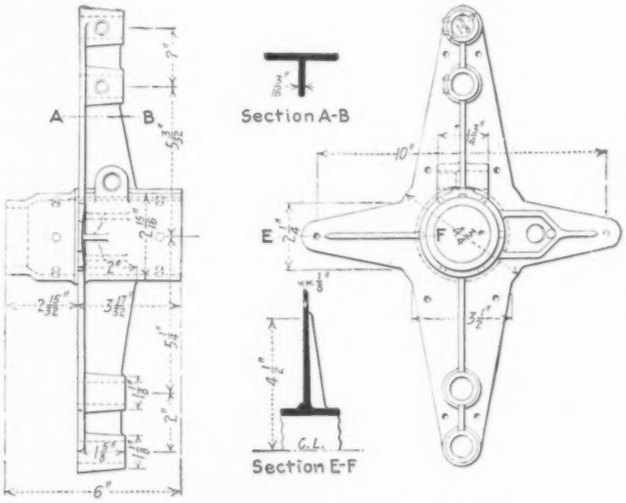


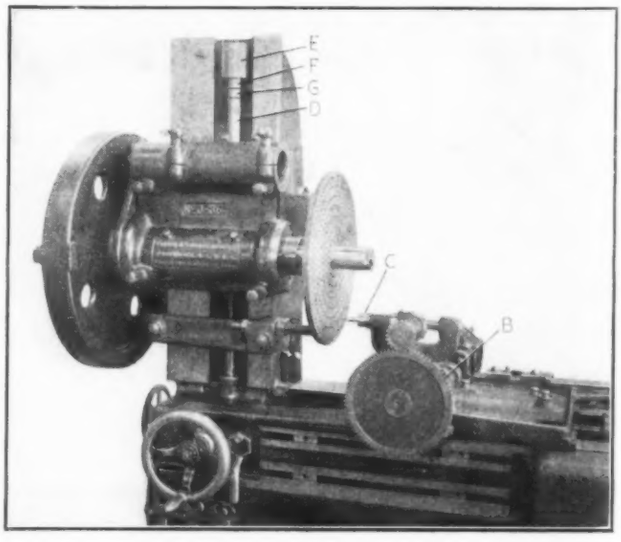
FIG. 2. DETAILS OF BRAKE SUPPORT

cinnati, Ohio, and the work is done in the shop of the Peru Auto Parts Co., Peru, Ind. The brake supports are of malleable iron, and the keyway cut is ¼ in. wide, $\frac{5}{32}$ in. deep and 3⅝ in. long. As the "hub" is 6 in. in length, it will be readily seen that the keyway goes only part way through and would be a difficult piece of work to do in any other way. The keyway is cut by the method described at the rate of about 4 in. per minute.

Drilling on a Gear Cutter

As part of a speed-changing mechanism used on the heads of its radial drilling machines, the Mueller Machine Tool Co., Cincinnati, Ohio, uses a gear consisting of a series of tool-steel pins set into concentric rings like crown gears. A tool-steel pinion meshes with the various rows of pins, according to the speed desired. It is necessary that these pins be set a certain distance apart in the individual rings and also that the rings be placed accurately in relation to each other. For this purpose a Brown & Sharpe gear cutter has been rigged up as shown.

The plate or gear in which the pins are to be pressed is placed on the work arbor, as shown at *A*. The drilling fixture is placed on the cutter carriage. The shaft of the spur gear *B* is connected to the cutter arbor and



DRILLING ATTACHMENT FOR A GEAR CUTTER

drives the drill spindle *C* through a pinion and pair of bevel gears. When set for a certain circle of holes, the drill feeds in and out, and the work is indexed by means of the regular gear-cutting mechanism. The spacing of the holes is obtained by gearing as for a gear with teeth corresponding to the number of holes to be drilled.

The setting for the various circles in the usual way, by turning the elevating screw a certain number of times, produced too many mistakes, so another method was thought out. A sleeve *D* was made to slip easily down over the elevating screw. A weight *E*, with a hole part way through it, rests on top of the screw. Between this weight and the long sleeve, spacing collars like *F* and *G* are placed, according to the row or circle of holes to be drilled. Suppose, for instance, that the first circle drilled requires the use of the long sleeve only. Then the weight is lifted off the screw, and a spacing collar is dropped on. The weight is then replaced and the head lowered until the long sleeve will just turn with the fingers. This gives the correct location for the next circle, which is drilled. Then another collar is slipped on to give the setting for the next circle, and so on. Each collar is marked for the number of holes and its circle.

Formulas and Alignment Charts for Taper Press Fits

By A Lewis Jenkins*

SYNOPSIS—A complete solution of the taper press-fit problem. The author has adapted tested fundamental press-fit formulas to the special case of the taper fit. Values for the numerical factors have been determined from the records of a large number of shops doing a wide variety of work. Two alignment charts plotted from the formulas provide easy use.

Taper press fits have found favor among leading manufacturers because of their simplicity and surety. By the use of proper standards and methods of gaging ("Halsey's Handbook," pages 245 and 251), systems of tapers and allowances have been developed which simplify computation.

The travel, or distance, the plug is forced into the ring by the pressure is a more satisfactory and practical criterion of the surety of a taper fit than the pressure itself. For this reason satisfactory records of taper press fits may be had even when they are made with a screw or knuckle-joint press.

The members of a taper fit may be placed together and the surfaces corrected to any degree of accuracy desired, thereby eliminating the necessity of making delicate micrometer measurements. The lubricant on a taper fit acts very effectively, and the possibility of scoring the surfaces in fitting is slight compared with the danger when making straight fits. The members of a taper press fit are easily centered, and accurate alignment is obtained at the beginning of the pressing operation.

Straight press fits have the following objections: They are difficult to measure accurately in fitting and difficult to lubricate satisfactorily when of considerable length; the surfaces of the members are likely to be scored in fitting; the operation of fitting requires extreme care on the part of the operator in starting and while pressing on, and the criterion of good design and workmanship is the total pressure required. This can only be determined with any degree of accuracy by using a hydraulic press, taking the gage reading of the liquid pressure and multiplying it by the area of the ram.

My fundamental equations for pressed fits, published in *Engineering News* of Mar. 17, 1910, and also given in the *American Machinist*, Vol. 42, p. 377, are as follows, with f and p expressed in pounds per square inch and P in pounds:

$$f = \frac{z E_2 K}{K + y_2 + \frac{E_2}{E_1}(1 - y_1)} \qquad (1)$$

$$p = \frac{z E_1}{1 - y_1 + \frac{E_1}{E_2}(K + y_2)} \qquad (2)$$

$$P = p \pi d L w \qquad (3)$$

where

f = Equivalent tensile hoop stress in the ring or hub in pounds per square inch;

p = Equivalent hoop stress at the surface of the shaft or plug, which is equal to the unit radial pressure between the surfaces fitted, in pounds per square inch;

z = Allowance per inch of diameter $= \frac{J}{d}$;

J = Total allowance in inches;

y_1 = Poisson's ratio for plug or shaft material;

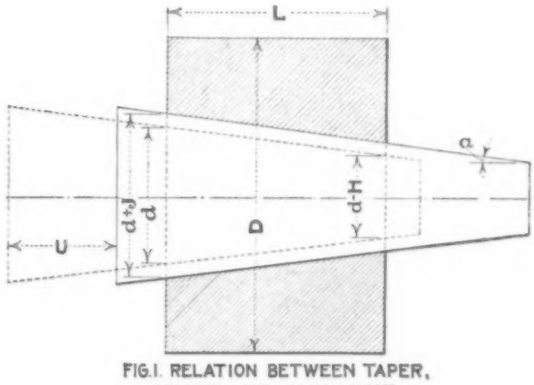


FIG.1. RELATION BETWEEN TAPER, TRAVEL AND ALLOWANCE

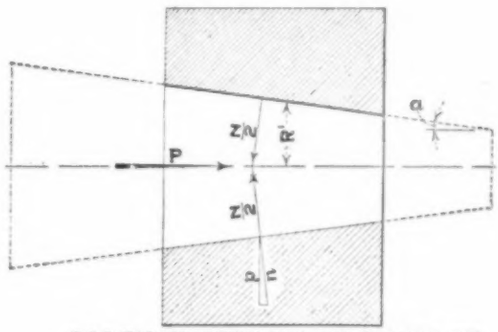


FIG.2. FORCES ACTING IN A TAPER-PRESS FIT

DIAGRAMMATIC REPRESENTATION OF CONSIDERATIONS IN TAPER-PRESS FITS

y_2 = Poisson's ratio for ring or hub material;

E_1 = Modulus of elasticity for plug material;

E_2 = Modulus of elasticity for ring material;

K = Ratio of hoop stress in the ring to the unit radial pressure between the surfaces $= \frac{f}{p}$;

L = Length of fit in inches;

w = Coefficient of friction;

d = Diameter of plug in inches.

Although these equations were first used in connection with straight fits, they may be modified to apply equally well to taper fits by using the proper values for w, z and J.

The dotted lines in Fig. 1 show a tapered plug placed snugly in a tapered hole. By forcing the plug to the right a distance equal to U, the hole is expanded and the plug contracted (not indicated in the drawing), and the section of the plug having a diameter equal to $d + J$ is forced into the bore at the section that originally was of

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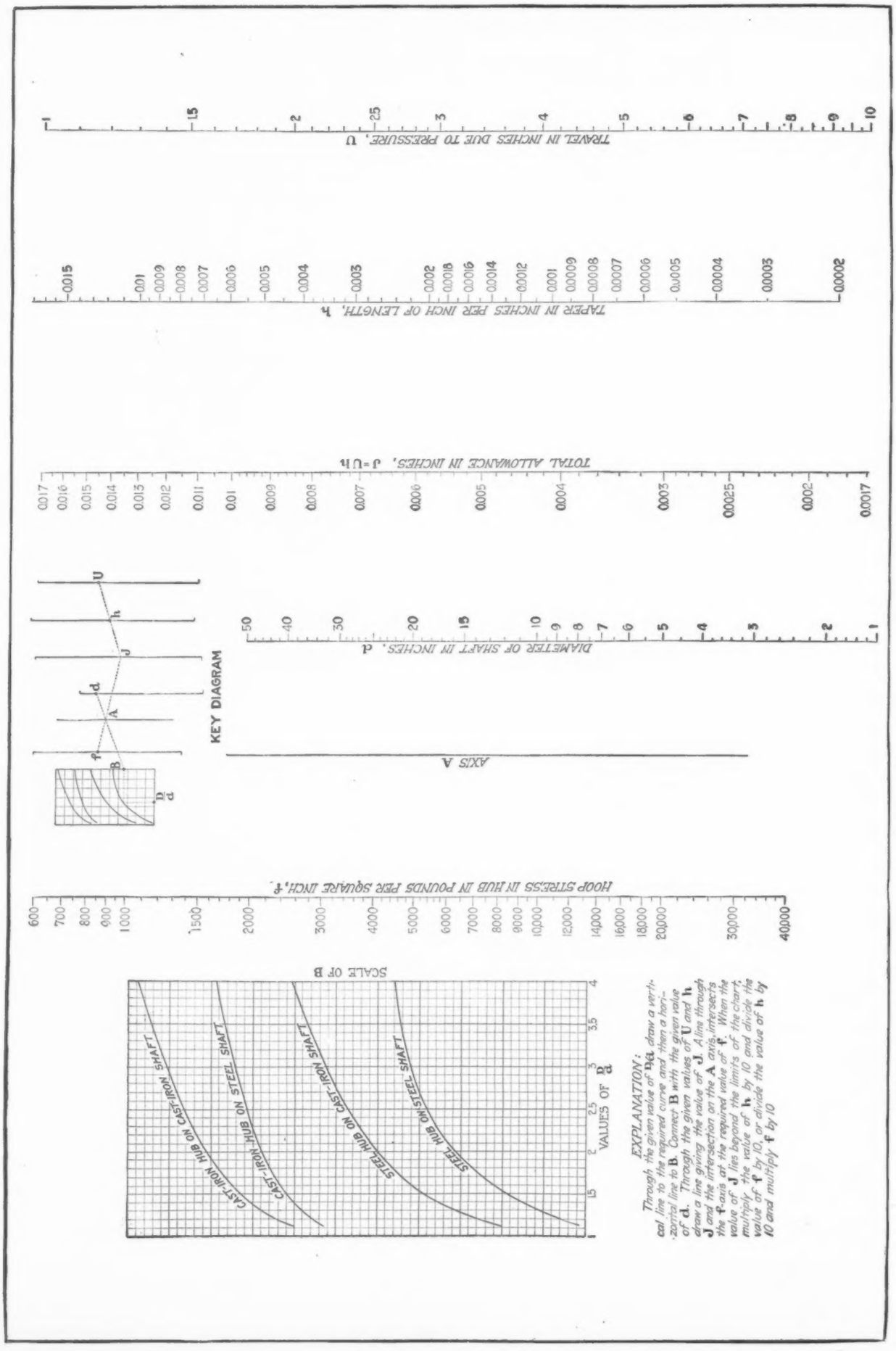

TRAVEL IN INCHES DUE TO PRESSURE, U
TAPER IN INCHES PER INCH OF LENGTH, f
TOTAL ALLOWANCE IN INCHES, J = U h
DIAMETER OF SHAFT IN INCHES, d
AXIS A
KEY DIAGRAM
HOOP STRESS IN HUB IN POUNDS PER SQUARE INCH, f
SCALE OF B
VALUES OF D/d
CAST-IRON HUB ON CAST-IRON SHAFT
CAST-IRON HUB ON STEEL SHAFT
STEEL HUB ON CAST-IRON SHAFT
STEEL HUB ON STEEL SHAFT
EXPLANATION:
Through the given value of D/d, draw a vertical line to the required curve and then a horizontal line to B. Connect B with the given value of d. Through the given values of U and h draw a line giving the value of J. A line through J and the intersection on the A axis intersects the f-axis at the required value of f. When the value of J lies beyond the limits of the chart, multiply the value of h by 10 and divide the value of f by 10, or divide the value of h by 10 and multiply f by 10

CHART 1. RELATION BETWEEN STRESS AND ALLOWANCE FOR TAPER PRESS FITS—BY A. LEWIS JENKINS

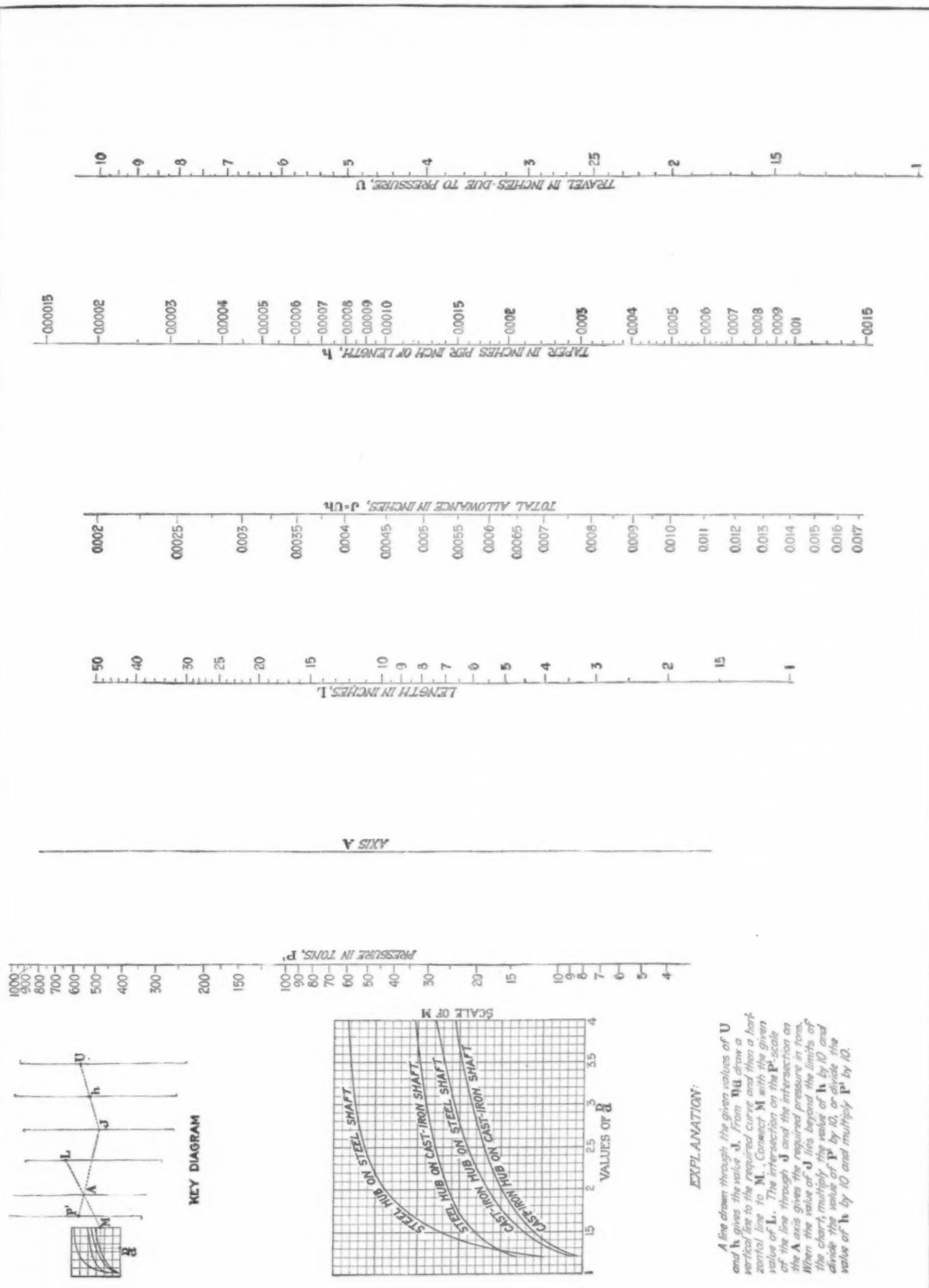

TRAVEL IN INCHES DUE TO PRESSURE, U
TAPER IN INCHES PER INCH OF LENGTH, h
TOTAL ALLOWANCE IN INCHES, J=Uh
LENGTH IN INCHES, L
AXIS A
PRESSURE IN TONS, P'
KEY DIAGRAM
SCALE OF M
VALUES OF M
STEEL HUB ON STEEL SHAFT
STEEL HUB ON CAST-IRON SHAFT
CAST-IRON HUB ON STEEL SHAFT
CAST-IRON HUB ON CAST-IRON SHAFT
EXPLANATION:
A line drawn through the given values of U and h gives the value J. From hJ draw a vertical line to the required curve and then a horizontal line to M. Connect M with the given value of L. The intersection on the P' scale of the line through J and the intersection on the A axis gives the required pressure in tons. When the value of J lies beyond the limits of the chart, multiply the value of h by 10 and divide the value of P' by 10, or divide the value of h by 10 and multiply P' by 10.

CHART 2. RELATION BETWEEN PRESSURE AND ALLOWANCE FOR TAPER PRESS FITS—BY A. LEWIS JENKINS

diameter d. For any section along the length of the fit the original diameter is changed an amount equal to the total allowance J.

The taper per inch of length is

$$h = \frac{H}{L} \tag{4}$$

where H is the total taper or difference in diameter of the bore at the ends of the fit.

The total allowance is equal to the difference in diameter of the tapered plug in a length equal to the travel U, or

$$J = Uh \tag{5}$$

The allowance per inch of diameter, or the unit allowance, is

$$z = \frac{J}{d} = \frac{Uh}{d} = \frac{UH}{dL} \tag{6}$$

Relation between Load and Radial Pressure for Taper Fits

Fig. 2 shows a tapered plug forced into a tapered hole in a ring by a load P, and thereby producing a unit normal pressure perpendicular to the surfaces equal to n and a total normal pressure between the surfaces equal to

$$N = \frac{P}{w \cos a + \sin a}$$

where a is half of the cone angle of the taper. (For derivation see "Spooner's Machine Design," pp. 342 and 111.)

Substituting the unit normal pressure, $n = \frac{N}{\pi d L}$, in this equation gives

$$P = \pi\, dLn\ (w\ cos\ a + sin\ a),$$

and since the radial pressure is equal to $p = n\ cos\ a$, and $tan\ a = \frac{h}{2}$,

$$P = \frac{\pi d L p\,(w \cos a + \sin a)}{\cos a} = \pi d L p\,(w + \tan a)$$

$$= \pi d L p \left(w + \frac{h}{2}\right) pounds \tag{7}$$

and

$$P' = \frac{\pi d L p}{2{,}000}\left(w + \frac{h}{2}\right) tons \tag{8}$$

By way of comparison, for a straight fit the total load required is $P = p\pi dLw$, where P is expressed in pounds.

This shows that for a given radial pressure p and coefficient of friction w a greater force is required to make a taper than a straight fit, the difference being equal to $\pi dLp\frac{h}{2}$ lb. It is also seen that the taper may be considered as having the effect of increasing the coefficient of friction an amount equal to $\frac{h}{2}$, or $w'' = w + \frac{h}{2}$, where w'' is the equivalent coefficient of friction. For $h = 0.005$, the equivalent increase in the coefficient of friction is only 0.0025, which is so small that it is well within the limits of error in observation and measurement. This does not mean, however, that the same or greater force is required for a taper as for a straight fit of the same length, allowance and diameter, because the conditions of lubrication are quite different and the coefficients of friction for the surfaces are not necessarily equal.

It is seen from equations 1 and 2 that the only physical properties of the material that affects the stress are the modulus of elasticity and Poisson's ratio. Steel has that interesting property of maintaining a constant modulus of elasticity regardless of alloys, heat treatments and mechanical treatments that change the elastic limit, ultimate strength and elongation. The influence of the variations in Poisson's ratio for ordinary grades of steel is not sufficiently great to produce an appreciable difference in the stress or in the load. Hence the variations in the physical properties of steels should have no appreciable effect on the stresses produced by a pressed fit.

The variation in hardness of the material may affect the coefficient of friction in equation (3), which in turn would affect the pressure required to make the fit, but this action is entirely independent of the stress relations. Soft materials, poor workmanship and inefficient lubrication tend to produce scoring. In practice the softness of the material is probably the least of these evils.

As regards press fits, steel is steel, whereas cast iron is a mere term applied to a mixture of iron, carbon, silicon and various other constituents, and it may have cavities and initial stresses. If cast iron has an elastic limit, it is at a point where the stress is almost zero, and its modulus of elasticity varies with the stress and grade of material. The exact error introduced by assuming a constant modulus of elasticity for cast iron within the practical limits of working stress and grades of material is small, but its exact value cannot be found.

(Our knowledge of the elastic properties of cast iron—the most used of all materials in machine construction—is very deficient. It is apparently no one's duty to discover the facts that will remove those mysteries which now often cause the designer to mistrust his calculations.)

General Formulas for Taper Press Fits

By substituting in the fundamental formulas (1), (2) and (3) the values of $E = 15{,}000{,}000$ for cast iron and $30{,}000{,}000$ for steel $y = 0.25$ for cast iron and 0.3 for steel, the equivalent coefficient of friction for taper fits, $w'' = w + \frac{h}{2}$, and allowance in terms of the proportions of the fit as given by the equation $z = \frac{Uh}{d}$, the following general formulas for taper press fits are obtained:

For cast-iron hub on a steel shaft:

$$f = \frac{15{,}000{,}000\,Uh}{d\left(1 + \frac{0.6}{K}\right)}\ lb.\ per\ sq.in. \tag{9}$$

$$p = \frac{15{,}0000{,}000\,Uh}{d\,(0.6 + K)}\ lb.\ per\ sq.in. \tag{10}$$

$$P' = \frac{15{,}000{,}000\pi Uh\,L\left(w + \frac{h}{2}\right)}{2{,}000\,(K + 0.6)} = \frac{23{,}562\,Uh\,Lw''}{K + 0.6}\ tons \tag{11}$$

For steel hub on a steel shaft:

$$f = \frac{30{,}000{,}000\,Uh}{d\left(1 + \frac{1}{K}\right)}\ lb.\ per\ sq.in. \tag{12}$$

$$p = \frac{30{,}000{,}000\,Uh}{d\,(1 + K)}\ lb.\ per\ sq.in. \tag{13}$$

$$P' = \frac{23{,}562\,UhLw''}{\frac{1+K}{2}} = \frac{47{,}124\,UhLw''}{1+K}\ tons \quad (14)$$

For steel hub on cast-iron shaft:

$$f = \frac{30{,}000{,}000\,Uh}{d\left(1+\frac{1.65}{K}\right)}\ lb.\ per\ sq.in. \quad (15)$$

$$p = \frac{30{,}000{,}000\,Uh}{d\,(1.95+K)}\ lb.\ per\ sq.in. \quad (16)$$

$$P' = \frac{47{,}124\,UhLw''}{1.95+K}\ tons \quad (17)$$

For cast-iron hub on cast-iron shaft:

$$f = \frac{15{,}000{,}000\,Uh}{d\left(1+\frac{1}{K}\right)}\ lb.\ per\ sq.in. \quad (18)$$

$$p = \frac{15{,}000{,}000\,Uh}{d\,(1+K)}\ lb.\ per\ sq.in. \quad (19)$$

$$P' = \frac{23{,}562\,UhLw''}{1+K}\ tons \quad (20)$$

The only variables in these equations that depend upon the physical properties of the materials are w'' and K. The combined effect of these has been determined empirically from experimental data.

Coefficient of Friction for Taper Press Fits

Lubricant has been found to have such a great influence over the pressure required in making taper press fits that the tonnage cannot be depended upon as a criterion. The variation in pressure required because of the lubricant may be as great as 600 per cent. ("Halsey's Handbook," page 245).

The lubricant is trapped between the surfaces and if it is not too thin, it is practically impossible for it to be squeezed out or scraped off. There is some tendency for the lubricant to be scraped off near the ends of a taper fit, but even over the small portions of the length at these places the conditions are no more severe than exist throughout the complete length of a straight fit. When a heavy paint made of linseed oil and white lead is used as the lubricant, the average tonnage required for a taper fit is between one-half and two-thirds that required for the average straight fit of the same allowance and proportions.

The results of an analysis of about 800 straight fits indicate that the coefficient of friction is greater on like materials than on unlike materials, whereas data on taper fits show that the friction of steel on steel is less than for cast iron on cast iron; while cast iron on steel has an intermediate value. This difference is presumably owing to the more efficient action of the lubricant in the case of taper fits.

The formulas for f, p and P' involve w'' and K, and it is necessary to assign values to these quantities in order to determine numerical results. The value of K for a given material depends upon the ratio of the outside diameter of the ring to the diameter of the shaft, the modulus of elasticity and Poisson's ratio. The modulus of elasticity is equal to 30,000,000 for any ordinary grade of steel stressed any amount within the elastic limit. The modulus of elasticity for cast iron depends upon the stress and grade of material. The effects of the variations of E and w'' or K and w'' for taper press fits may be found as follows:

It has been seen from equations (11), (14), (17) and (20) that the total pressure in tons required to force a shaft into a hub may be written

$$P' = \frac{NUhL}{Q} = MUhl \quad (21)$$

where

$$N = \frac{w''E}{2{,}000} \quad (22)$$

$Q = 0.6 + K$, $1 + K$, etc., depending on the material and

$$M = \frac{N}{Q} = \frac{P'}{UhL} \quad (23)$$

The correct value of M includes the function of the elastic laws and corrects any error that may be introduced by assuming constant values for E and y. The values of P', U, h and L taken from experimental data were substituted in the foregoing equation and the values of M plotted against the corresponding values of $\frac{D}{d}$.

In order to obtain the necessary data for this analysis, a circular letter and "record form" were mailed to about 70 concerns that use press fits. The replies cover a large range of sizes and classes of work. These data show a much greater variaton in the pressure required than was found in making a similar analysis of straight fits. This is accounted for by the fact that the data on taper fits cover a greater variety of work, were taken from a greater number of sources and have greater personal and instrument errors, and the kind of lubricant used has a greater effect on the coefficient of friction for taper than for straight fits.

By plotting the values of M against $\frac{D}{d}$ for taper fits, the mean value of M for a cast-iron hub on a steel shaft when a lubricant of linseed oil and white lead was used, is:

$$M = \frac{1{,}260}{0.6+K} \quad (24)$$

where

$$K = \frac{1.7}{\left(\frac{D}{d}-1\right)^{0.4}} \quad (25)$$

This equation for K is of different form from the one given for straight fits, but the curves plotted from the two equations practically coincide between the values of $\frac{D}{d} = 1.4$ and 4.

The data for steel hubs on steel shafts also give considerable variation, the mean values being represented by the equation

$$M = \frac{2{,}600}{1+K} \quad (26)$$

where

$$K = \frac{\left(\frac{D}{d}\right)^2+1}{\left(\frac{D}{d}\right)^2-1} \quad (27)$$

which is the ratio of the tangential hoop stress in the hub to the internal radial pressure as expressed by the Lamé theory for stresses in thick cylinders.

There are relatively few instances where cast-iron hubs are forced on cast-iron shafts, either straight or tapered. From the data for taper fits for cast-iron hubs on cast-iron shafts the mean value of M is represented by the equation

$$M = \frac{1{,}390}{1 + K} \qquad (28)$$

where K is the value given by equation (25).

There are apparently no available data on steel hubs pressed on cast-iron shafts, and the values of M and K for this case were chosen through a comparison of the other three cases. In deciding whether the values of K for cast-iron hubs on steel shafts or the value for steel hubs on steel shafts should be used for steel hubs on cast-iron shafts, constant values of U, h, L and w'' and a value of K—1.7 were substituted in equations (11), (14), (17) and (20) for P', and the following ratios of the required pressures deduced:

$$\frac{\textit{Cast-iron hub on cast-iron shaft}}{\textit{Steel hub on steel shaft}} = 5.00 \qquad (A)$$

$$\frac{\textit{Cast-iron hub on steel shaft}}{\textit{Steel hub on steel shaft}} = 5.88 \qquad (B)$$

$$\frac{\textit{Steel hub on cast-iron shaft}}{\textit{Steel hub on steel shaft}} = 7.40 \qquad (C)$$

$$\frac{\textit{Steel hub on steel shaft}}{\textit{Steel hub on steel shaft}} = 1.00 \qquad (D)$$

This shows that if the materials gave the same values for w'' and K, and the values of E and y assumed were correct, the force required to press a steel hub on a steel shaft is twice as great as is required to fit a cast-iron hub on a cast-iron shaft of the same dimensions.

The actual values of (A), (B) and (D) obtained from data on straight fits are respectively equal to 5.9, 5.7 and 1. The values for (A) and (B), which are for like materials, are comparatively larger than the aforementioned value of (B), as may be seen by multiplying either set of values through by a constant that will make both values of (B) equal. The fact that the actual value of (A) is greater than 5 indicates that the friction of cast iron on cast iron is greater than steel on steel. The variations in the values of E are not sufficient to produce so great a difference. By comparing the values of (A) and (B) for both cases it is seen that the friction in case (A) is greater than in case (B), or the friction of cast iron on cast iron is greater than cast iron on steel.

The actual values of (A), (B) and (D) obtained from data on taper fits through equations found for M are respectively equal to 5.28, 5.61 and 1.00 and are consistent in their agreement with the hypothetical case. By comparing the differences between (A) and (C) and (B) and (C) the influence is in favor of cast iron, hence the value of K given by equation (25) was selected.

By proportion the actual value of (C) should be

$$(C') = \frac{(D')(C)}{(D)} = \frac{5.61 \times 7.4}{5.88} = 7.05$$

which gives for a steel hub on a cast-iron shaft

$$M = \frac{2{,}510}{1.95 + K} \qquad (29)$$

where K is the value given by equation (25).

Substituting the empirical values of K and M obtained from experimental data in the general equations (9) to (20) gives the following empirical formulas:

For cast-iron hub on steel shaft: By combining equations (9) and (25) the hoop stress in a cast-iron ring pressed on a steel shaft having the same taper as the bore is

$$f = \frac{15{,}000{,}000\,Uh}{d\left[1 + 0.353\left(\frac{D}{d} - 1\right)^{0.4}\right]}\ lb.\ per\ sq.in. \qquad (30)$$

From equations (21), (24) and (25) the force required to press a tapered steel shaft into a cast-iron ring bored to the same taper is

$$P' = MUhL = \frac{1{,}260\,UhL}{0.6 + \frac{1.7}{\left(\frac{D}{d} - 1\right)^{0.4}}}\ tons \qquad (31)$$

For steel hub on steel shaft: From equations (12) and (27):

$$f = \frac{15{,}000{,}000\,Uh\left[\left(\frac{D}{d}\right)^2 + 1\right]}{d\left(\frac{D}{d}\right)^2}\ lb.\ per\ sq.in. \qquad (32)$$

From equations (21), (26) and (27):

$$P' = \frac{1{,}300\,UhL\left[\left(\frac{D}{d}\right)^2 - 1\right]}{\left(\frac{D}{d}\right)^2}\ tons \qquad (33)$$

For steel hub on cast-iron shaft: From equations (15) and (25):

$$f = \frac{30{,}000{,}000\,Uh}{d\left[1 + 0.97\left(\frac{D}{d} - 1\right)^{0.4}\right]}\ lb.\ per\ sq.in. \qquad (34)$$

From equations (21), (25) and (29):

$$P' = \frac{1{,}475\,UhL\left(\frac{D}{d} - 1\right)^{0.4}}{1.15\left(\frac{D}{d} - 1\right)^{0.4} + 1}\ tons \qquad (35)$$

For cast-iron hub on cast-iron shaft: From equations (18) and (25):

$$f = \frac{25{,}500{,}000\,Uh}{d\left[1.7 + \left(\frac{D}{d} - 1\right)^{0.4}\right]}\ lb.\ per\ sq.in. \qquad (36)$$

From equations (21) and (28):

$$P' = \frac{1{,}390\,UhL}{1 + \frac{1.7}{\left(\frac{D}{d} - 1\right)^{0.4}}}\ tons \qquad (37)$$

There is no question about the foregoing values of f being sufficiently accurate for all practical purposes, but owing to the great variation in the pressure required because of the different kinds of lubricant used, the formulas for P' may give values considerably greater or less than the actual pressures required. They represent average values when a lubricant of white lead and linseed oil is used.

The alignment charts provide an easy means of solving these equations.

Maximum Production from Tools

By Gustav H. Radebaugh*

SYNOPSIS—The centralized control of a school shop planned to teach the principles of production and govern the manufacturing in the shop itself. A number of special tools are shown, together with specimen time-study and instruction cards.

Tools have but one function—to produce work. Failure to perform this function according to definite standards accepted as modern practice points to fundamental defects in the manufacturing policy. Tools that do not produce a maximum quantity of acceptable work are expensive tools, while those that lie on the shelves unsued are a dead loss. If tools are good but production low,

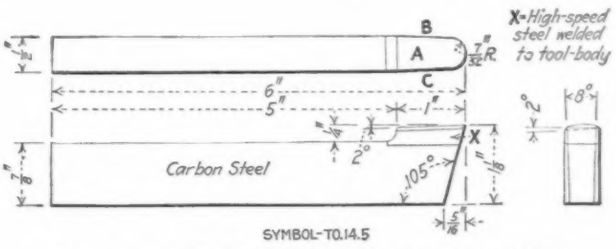


FIG. 1. ROUND-NOSE TOOL FOR HEAVY WORK

methods are at fault. In either case something is wrong with the underlying policy or with the execution of that policy.

The manufacturer who does not know is satisfied with poor tools and low production for the reason that to him his tools do not appear bad nor his production small. Who has not observed the widely varying tool practices in shops similarly equipped and engaged in the same kind of work? The tools are approximately the same and the workmen seemingly of equal ability, yet the results are in no way comparable. Plainly the tools or the workmen are not responsible, as in these respects conditions are equal. These cases leave but one conclusion—the management must be responsible for the difference in results. In one case the management is good; in the other it is bad, or at least not of an equal degree of excellence. Inefficiency is not so much a matter of tools as of methods, and observation leads to the conclusion that in the shop which is not producing results equal to those produced by other shops of the same order, the management rather than the equipment is at fault.

The problem of securing maximum production from tools resolves itself into three factors—(1) design of the tool, (2) manipulation of the tool, (3) maintenance of the tool.

Such output of course depends upon a number of items other than tools, such as dispatching and routing of materials, power, labor, etc., all of which enter directly into the larger problem of manufacturing and must, if efficiency is secured, receive equal attention with the tools. Without consistent treatment of all the fundamental elements entering into shop operation, efficiencies in one will necessarily be nullified by inefficiencies in another, and the final result average but little better than the weakest constituent. The plans outlined in this article would not in themselves effect the maximum shop output, for the reasons just given, but they will name (1) the right tool for the work, (2) the most effective use of the tool and (3) proper tool upkeep and maintenance. Such a program, if effectively executed, will furnish the fundamental elements for successful shop operation when combined with efficient organization and management.

Considering in detail each of the three leading factors in maximum tool production, it is evident that (1) to secure the most effective tool it must be selected for the work, properly designed, mechanically constructed; (2) to obtain maximum output from the tool, the most economical method of performing the work must be determined in advance, these methods and standard time for operations must be made available for the workingman's use, the workman must be trained to perform the work according to methods and in specified time; (3) to insure a constant supply of tools in efficient working condition, working standards must be established, these standards must be constantly maintained, the workman must be relieved of all responsibility for tool maintenance and not be permitted to depart from standards.

To some of the shop managers of the old school this program may appear unduly complicated and perhaps unnecessary. Its justification lies in the fact that it produces more work at less cost than does unsystematized management. Unless definite steps such as those outlined are taken to standardize shop processes, production is largely a matter of efficiency of the individual work-

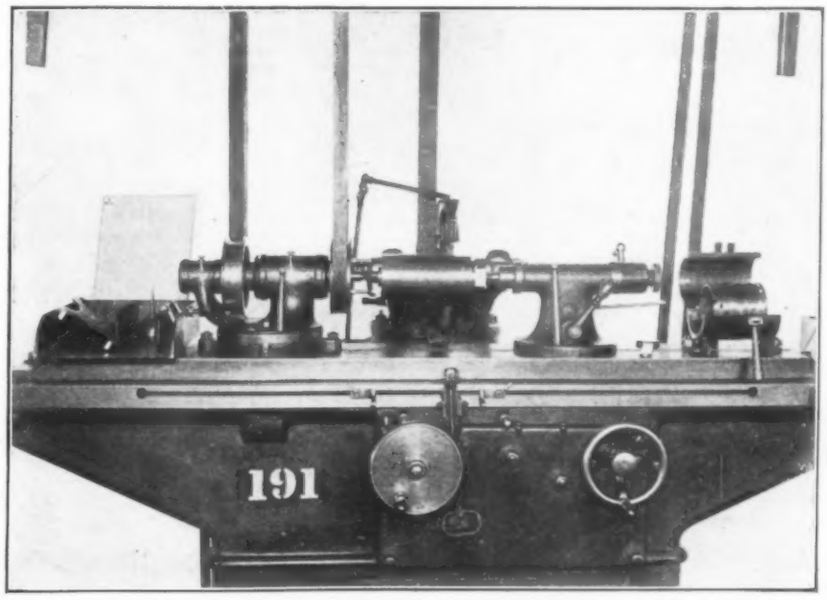


FIG. 2. GRINDING FIXTURE FOR GAS-ENGINE PISTON RINGS

*Instructor in machine-shop management and practice, University of Illinois.

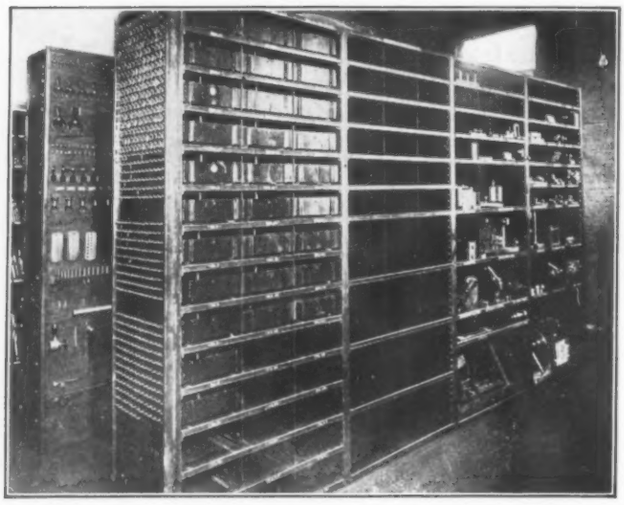


FIG. 3. ADJUSTABLE STORAGE CASES FOR STORING JIGS AND FIXTURES

man. In ability workmen vary greatly. There are equally marked differences in individual outputs, owing to the relative values of experience and training. On the other hand the average workman responds readily to intelligent instruction in modern shop practices, and it is not difficult to improve efficiency when those in charge are real leaders. Most inefficient shops are the results of poor leadership. Efficiency starts (if it starts at all) at the top and filters down through departments to the workman himself. It does not work back the other way. These facts are appreciated by the uptodate executive, which is the reason why centralized control from the office is gradually superseding the traditional plan of machine control by the individuals operating machines.

In the shops of the University of Illinois centralized control has been established for the double purpose of demonstration and of production. These shops are operated on a commercial basis. Regular products are manufactured to give students actual experience in the problems of shop management. No claim for novelty is made for the methods used, although these shops are among the first of the college shops to employ throughout the latest phases of production and management in place of manual training. The hope that some of these methods may prove helpful to those facing similar problems is the source of inspiration for this article.

At present an 8-hp. two-cylinder marine-type gas engine is the principal shop product. To machine the 86 parts of this engine 214 operations at various machines are required. Each part was studied separately, and the most efficient tools and methods under existing conditions were selected. It is not presumed that these are ideal in all respects, but they represent in principle at least the working out of a sound manufacturing policy. The problem of production from the mechanical standpoint involved in the manufacture of the gas engine was considered as one having three components—the right tool, efficient operation and correct maintenance.

Each tool is designed for machine production with the ultimate idea of having it perform its functions in the most effective manner. This is accomplished by determining the machining operation routine, thus permitting the design of tools to embody both the character of the work and machining methods. In designing lathe, planer and shaper tools, practices which standardize these tools are followed. In Fig. 1 a round-nose tool for heavy work is shown. This tool is made up of a carbon-steel body with high-speed steel nose welded to the carbon steel. The construction of this tool eliminates the extravagant use of high-speed steel and also gives productive results.

FORM 7
UNIVERSITY OF ILLINOIS
SHOP LABORATORIES

RECORD OF TIME STUDY

DEPT. Machine

OPERATION Grinding Piston Rings
ARTICLE Type A Engine
INSTRUCTION CARD NO. 107 OPER. NO. 4
OPERATOR'S NAME A. Miller NO. 78 SEC P
DATE February 17, 1914 TIME STUDY NO. 4

ITEM	DETAILS OF OPERATION	TIME ACTUAL	TIME LOST	TIME PROPOSED	EXPLANATION OF OPERATING TIME LOSSES
1	Adjusting head and foot stock	0.08	0.04	0.03	Nut too tight on platen bolt. Had to remove nut and repair it.
2	Adjusting head-stock center	0.03		0.03	
3	Placing grinding wheel on spindle	0.08		0.08	
4	Adjusting speeds	0.03		0.03	
5	Locating reversing dogs	0.02		0.02	
6	Clamping ring grinding fixture on platen	0.03		0.03	
7	Placing rings in clamp box	0.03	0.01	0.02	One ring too large to go in fixture. Had to replace with another.
8	Place equalizing dog on mandrel	0.01		0.01	
9	Placing rings on grinding mandrel	0.02		0.02	
10	Grinding to size	0.20	0.02	0.19	Took 8 cuts when it should be done in seven.
11	Removing mandrel from machine and ring from mandrel	0.03		0.03	
12	Removing fixtures from machine	0.10		0.10	
	TOTALS	0.66	0.07	0.59	

INVESTIGATED BY: G. Ritter, WORK SCHEDULE ENGINEER. STUDY MADE BY: H. Hess, WORK SCHEDULE ASSISTANT.

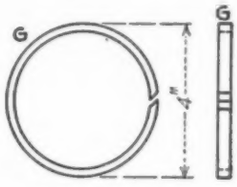
FIG. 4. A SPECIMEN RECORD OF TIME STUDY

This is one of a series of eight time studies made on a grinding operation incorporating an accurate record of all details in natural sequence

FORM 134
A 107-4 **INSTRUCTION CARD**
SHOP LABORATORIES
MACHINE DEPT.

STOCK No. A-107 PATTERN No. 1-25

PISTON RING
PATT. NO. 1-25
OPERATION NO. 4 4 TOTAL OPERATIONS
MACHINE GRINDING
MACHINE NO. 191
TOOLS: 4" MICROMETERS. Ca. 13.4
JIGS:
FIXTURES: GRINDING Fx. 107.4



ITEM	OPERATION ROUTINE	STANDARD TIME
	Note:-Rings finished in lots of 18 pieces. During process of grinding prepare next set of rings on grinding mandrel No. 2.	
	Machine set up. Total time ..0.14	
1.	Adjust head and foot stock to receive work. (Par. 47). ...	0.02
2.	Both center dead. (Par. 49). ...	0.03
3.	Place on wheel spindle, wheel grain 46, grade K or L shape 76.(Par. 105). ...	0.06
4.	Adjust wheel speed to No. 6 (Par. 83. Traverse speed No. 3 (Par. 84).	0.02
5.	Adjust reversing dogs to proper position. (Par. 52). ...	0.01
	Work set up. Total time ..0.07	
6.	Clamp Ring grinding fixture Fx 107.4(clamp box) on right end of platen. (Par. 183). ...	0.02
7.	Place 18 piston rings in clamp box and close clamp. (Par. 187). ...	0.02
8.	Place equalizing dog on mandrel. (Par. 144). ...	0.01
9.	Place special grinding fixture mandrel thru 18 rings and clamp firmly release ring clamp box. (Par. 187). ...	0.02
	Work Production. Total time ..0.20	
10.	Place mandrel with 18 piston rings, between centers and grind to 4" diameter. (Par. 142). ...	0.17
11.	Remove mandrel from machine, and piston rings from mandrel. (Par.143)	0.03
	Note:-If more than 18 rings in lot, repeat items 7-9-10--11.	
	Machine Take Down Total time ..0.09	
12.	Remove all fixtures from machine. (Par. 10). ...	0.09
	Standard time in lots of 18 = 0.24 x number of lots	
	Standard time in one lot of 18 = 0.50	
	TOTAL STANDARD TIME	0.50

FIG. 5. A SPECIMEN INSTRUCTION CARD

Operators are not permitted to depart from the instructions but are encouraged to make suggestions for betterment

In efficient manufacturing, jigs and fixtures are the foundations for production. Their design and maintenance is an item of no brief analysis. They are designed with the double purpose of accuracy and rapid production. If designed without first analyzing the machine operation or without consideration for rapid production and the placing of work in them, they will not effectively fufill their purpose. Fig. 2 shows the fixture used for grinding the periphery of piston rings, the grinding being done under compression; 18 rings are ground at one setting. The clamping box shown mounted on the machine obviates wastes in placing the rings on the fixture.

STANDARD TOOL LIST
INSTRUCTION CARD A 140-1

6 IN. STEEL RULE	RU 19.5
1 IN. MICROMETER	CA 13.1
3-8 IN. HEX. COLLET	CO 20.6
PARTING TOOL	TO 16.2
3-8 IN. HOLLOW MILL	MI 8.4
3-4 IN. SOCKET	SO 20.3
3-8 IN. – 24 DIES	DI 7.9
GEOMETRIC DIE HEAD	DI 7.1

FIG. 6. STANDARD TOOL-LIST CARD FOR TOOLS, JIGS AND FIXTURES

In an operation of this character two grinding fixtures or mandrels are supplied with one clamping box. Thus the operator arranges the rings on one mandrel during the grinding operation with the other. Notice the rapid cam lock on the clamping box. Designs of this description aid in shortening the setting-up time.

Tools not only must be properly designed, but they must be adequately stored to facilitate issuing to the machine department in the minimum of time and to insure their proper care. Different methods of storing tools might be employed, but the fundamental factors of a correct storage plan must be the marking of tools and the use of individual storage locations. Fig. 3 shows a section of jig and fixture storage, special tools and tool trays. All jigs and fixtures are marked with symbols;

NAME OF TOOL_____ SYMBOL_____ SIZE_____
STEEL, KIND_____ MAKE_____
DESCRIBE FAILURE_____
METAL BEING MACHINED_____ HARD OR SOFT_____
TIME TOOL IN SERVICE_____ CONDITION AT START_____
SPEED OF WORK_____ FEED OF TOOL_____
LUBRICANT USED_____
YOUR REASON FOR FAILURE_____
STATEMENT BY:_____ APPROVED BY:_____
NAME OF STUDENT INSTRUCTOR

FIG. 8. SHOP LABORATORIES' RECORD OF TOOL STEEL PERFORMANCE

compartments in the storage case are marked to show individual storage space. The mark on the storage space is the symbol number of the tool.

The machine operator must have such information as will assist him in effective use of the tools furnished to him. The determining of such information includes (1) the unnecessary operations performed, (2) the time consumed in performing such operations, (3) the necessary operations for the complete process, (4) the time required to perform such operations. The conclusions deduced from these observations include the most efficient method of performing the process, the logical sequence of required operations and the rational time allowance for completing the process. The collecting of this information becomes then a matter of detail which in turn involves a time study of the operation.

Fig. 4 gives an excellent idea of time study. It shows the record sheet used when a time study is being made. Time studies that do not present an accurate record of the various details in natural sequence from start to finish are unquestionably worse than none. The time-study record sheet, as shown in Fig. 4, provides an arrangement incorporating all the principles and facts concerning existing processes, such as waste and non-productive motions, imperfect facilities, uneconomical methods, improper organization and consequent inefficiencies, so that analysis may be directed to determining the best methods

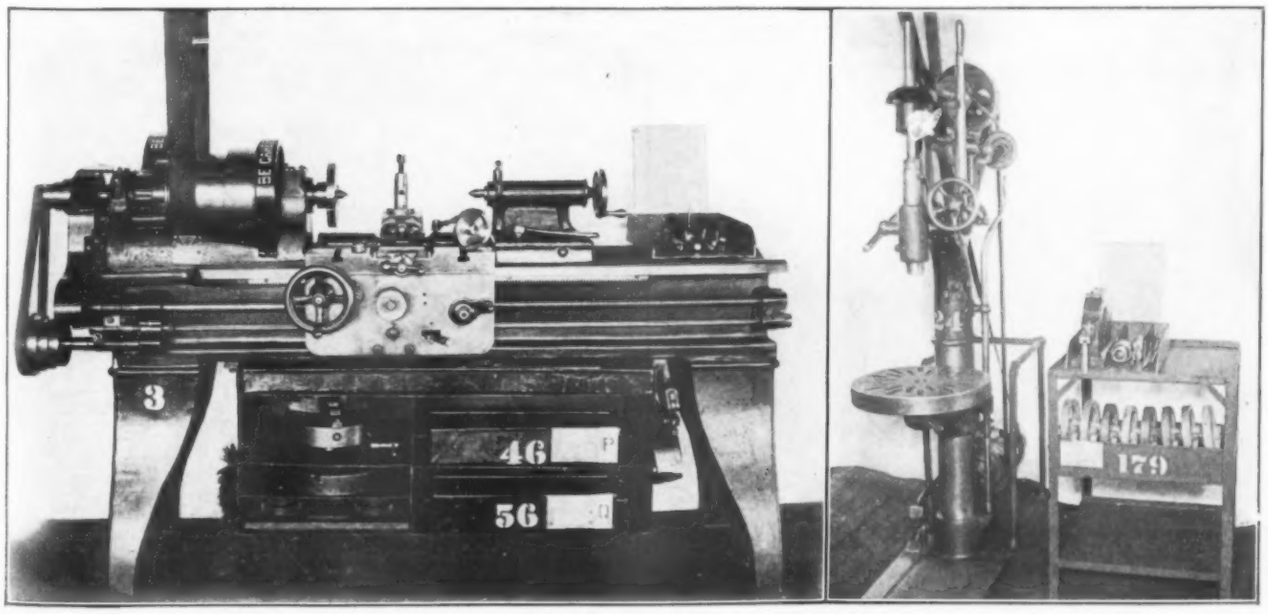


FIG. 7. TOOL TRAYS AND MATERIAL AT ENGINE LATHE AND DRILLING MACHINE

of operation. This analyzed information is conveyed to the operator in the form of a work-schedule card or the instruction card, as shown in Fig. 5.

Productive manufacturing demands standardized operations. Information for the machine operator must be clear and accurate. The instruction card provided for each operator presents the standard procedure, stating not only items of operation but the speeds and feeds of the machine as well. With such information at hand the operator does not use valuable time in trial machine setups but spends all his time on work of a productive nature. The instruction card also gives the standard time of the various items of operation, such information being obtained from the time-study analyses.

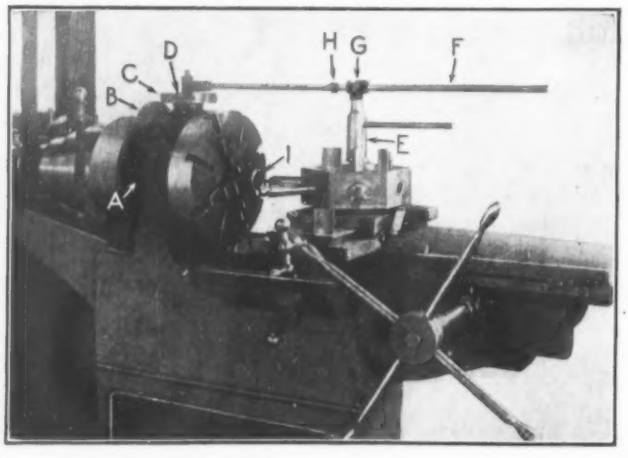
In the standardizing of machine operations the list of tools required to complete the operation is for convenience given on the instruction card. It is obvious that the tool-crib attendant, if he is to eliminate the calling for tools, must have definite knowledge of the needs of the machine operators before their arrival at work. This information is listed on a standard "tool-list card," Fig. 6. The tool, jig and fixture requisites of a standard operation are delivered to the machine before the arrival of the operator. Notice, in Fig. 7, that tools, machine and materials are awaiting the arrival of the operator.

On the return of the tools, jigs, etc., after use in the machine department they are given a close inspection for breakage and regrinding. If need be, they are repaired or resharpened before going into the service rack for future issuance. Tools needing grinding or tools breaking in service are turned into the toolroom and new tools obtained. For all tools breaking in service one copy of form 13, "Record of Tool-Steel Performance," Fig. 8, is made out and approved by the foreman or instructor before a new tool may be obtained.

Oil-Grooving Attachment for a Turret Lathe

By E. A. Thanton

An interesting oil-grooving attachment used on a Davis turret lathe is here shown. It was made in the shop of the Mueller Machine Tool Co., Cincinnati, Ohio.



OIL-GROOVING ATTACHMENT FOR A LATHE

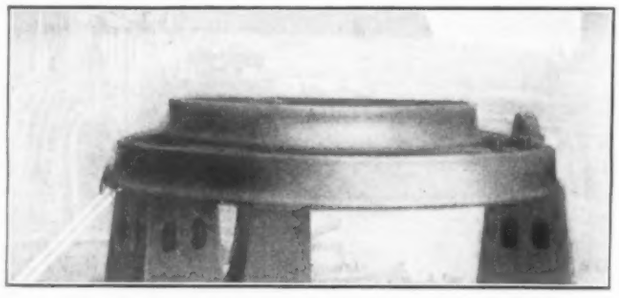
Extension studs are used in place of the regular screws on the front bearing cap of the spindle. The attachment is set over these studs.

A spur gear *A* remains permanently on the spindle between the cone and the front bearing. This gear meshes with another spur gear *B*, and through it and a series of reduction and bevel gears drives the crank disk *C*. The crank disk has a slide in it, adjusted by means of a screw *D* to vary the length of the stroke as desired. A special extension *E* is used on the turret. This is clamped to the connecting-rod *F* by means of a split bearing and capscrew at *G*. A stop collar *H* is used so that the clamp may be loosened and the turret run back for the removal or insertion of work in the chuck at *I*.

Either single- or double-point tools may be used in the bars in the turret, according to the grooving required in the bushings. Arrangements are also provided to give different gear ratios for different groove patterns.

An Improvised Bending Form in a Railway Shop

The illustration shows a bending form used at the shops of the Union Pacific System, at South Tacoma, Wash. It consists of two discarded locomotive tires of different



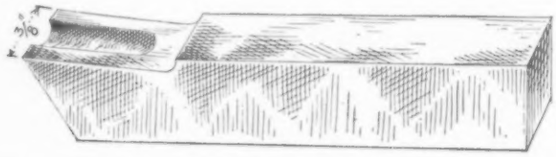
FORM FOR BENDING CURVES

sizes, held together by crossbracing and mounted on the three pedestals shown. Means are provided for clamping to the tires at any point the material to be bent. The device is located in the yard just outside the machine shop and is found very handy in many instances.

Curved-Lip Parting Tool for Planer or Shaper

By S. L. Roberts

Herewith is shown a parting or cutting-off tool for shaper or planer work on cast iron. Not having tried it on steel, I cannot say how it would work on that material. In cutting cast iron, however, the tool starts the cutting on the two corners and the chip runs to the center of the



PARTING OR CUTTING-OFF TOOL FOR SHAPER OR PLANER ON CAST IRON

radius, sometimes hanging together for an inch before breaking. It follows up the radius shown by the dotted line. I have failed to hear this tool chatter, and it is 3/8 in. wide. I find it the best parting tool I have tried during considerable experience.

Machining Methods Used on a Valveless Lubricant Pump

By Ethan Viall

SYNOPSIS—The principal parts of this valveless pump are the body, the impeller and the cover. The machining methods and the tools used are simple and free from complications and afford an interesting study.

The pump the machining of which is described in this article was designed to supply lubricant to cutting tools of various kinds. Two of the complete pumps and two sets of the principal castings are shown in Fig. 1. Both of the complete pumps shown are geared-up types, though a direct-driven type is also made. The main parts are, however, the same in both types. The castings *A* and *B* show different views of the body. *C* and *D* are impellers and *E* and *F* are covers. Only work on these parts as done in the shop of the Cincinnati Lubricant Pump Co., Cincinnati, Ohio, will be shown. The shafts, bushings and other small parts are machined in the usual way and offer nothing of special interest.

The geared-up type is shown in detail in Fig. 1-A, which gives a good idea of the operation of the pump. The body itself is 5⅜ in. in outside diameter and is bored to two diameters—4 and 2 in. respectively. With the cover in place, the pump is 3⅛ in. through, regardless of the pipe and shaft bosses. The impeller is 4 in. in diameter and 2⅛ in. at the thickest part. The cover is 5 in. in diameter and ½ in. thick at the flanges. The impeller drive shaft is ⅝ in. in diameter. The complete pump weighs about 14 lb. With a suction lift of 12 in. and a head lift of 4 ft. the pump will deliver the following amounts of lubricant with the pulley running as

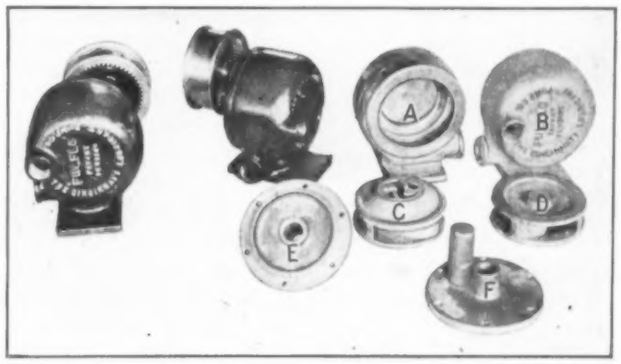


FIG. 1. FINISHED PUMPS AND PRINCIPAL PARTS

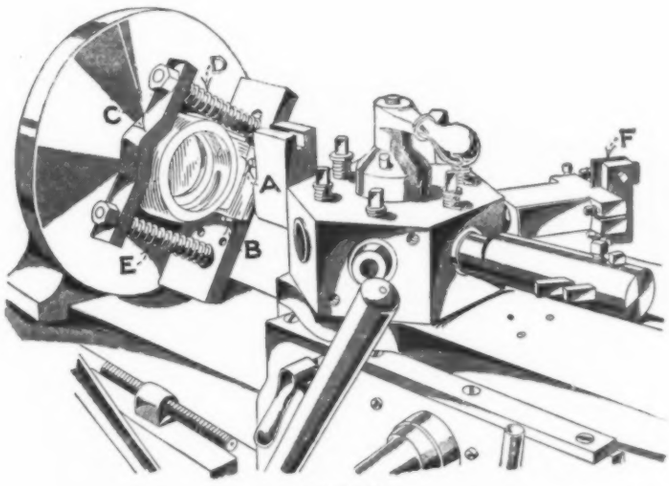


FIG. 2

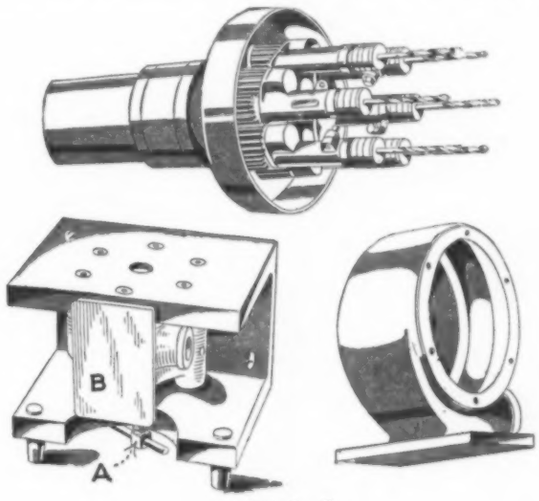
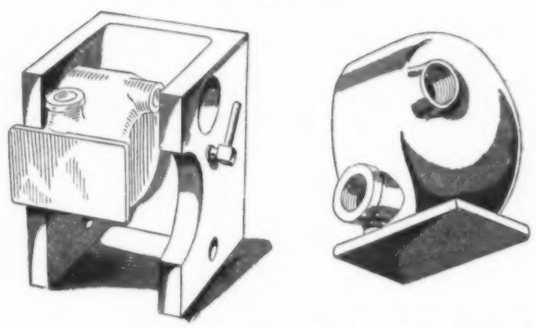


FIG. 3



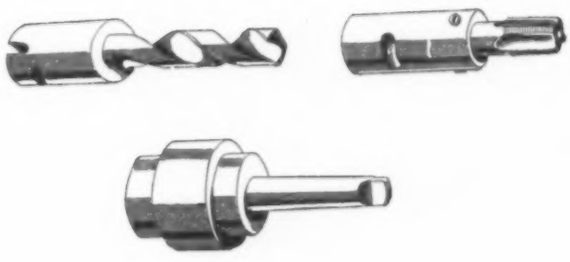


FIG. 4

FIGS. 2 TO 4. OPERATIONS AND TOOLS FOR MACHINING LUBRICANT PUMP BODIES

Fig. 2—Facing and boring bodies. Fig. 3—Drilling head and jig for body screw holes. Fig. 4—Jig and tools for drilling and tapping inlet and outlet pipe openings

indicated: 5 gal. at 250 r.p.m.; 10 gal. at 300 r.p.m.; 15 gal. at 350 r.p.m.; 18 gal. at 400 r.p.m.

If more lubricant is wanted at this head, the speed is increased. The same thing is necessary if the amount indicated is wanted with a higher head lift.

The first operation on body castings is to face and bore them. This is done in a turret lathe, as shown in Fig. 2. The rough casting is held on an angle plate bolted to the lathe faceplate. The base of the casting is located between the two pins *A* and *B*. The strap *C* is then tightened down, holding the piece securely. It will be noted that springs *D* and *E* are provided to lift the strap free of the casting as soon as the nuts are loosened. The casting is first rough-faced, two tools being used and each one taking off about half of the surface. The next step is to rough-bore both diameters. The tool *E* is then run in to finish and size all turned surfaces.

From the turret lathe a body goes to the drilling machine, where the screw holes for the cover are drilled. The jig and drilling head are shown in Fig. 3. The under side of the upper jig plate has fastened to it a locating disk that just fits the bore of the casting. A setscrew *A* locks the casting in place. The base flange *B* is set approximately by the eye, as a little difference one way or the other does not matter. The six holes are then drilled with the Covington multiple head, shown at the left.

The next operation is the drilling and tapping of the inlet- and outlet-pipe openings. The casting is placed

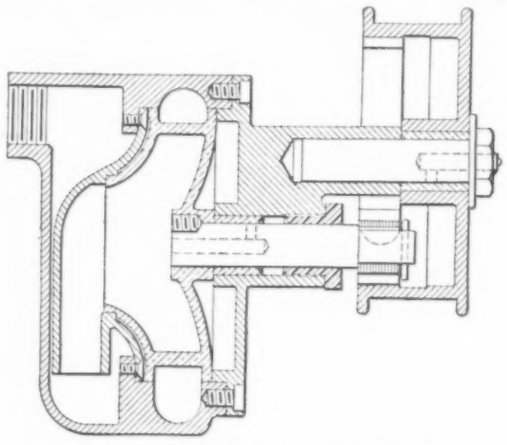


FIG. 1-A. DETAILS OF THE PUMP

in a jig, as shown in Fig. 4. The locating and holding are exactly the same as in the previous jig. The holes are cored out, so no bushing is used to guide the drill, as this is accurate enough for all purposes. The holes are

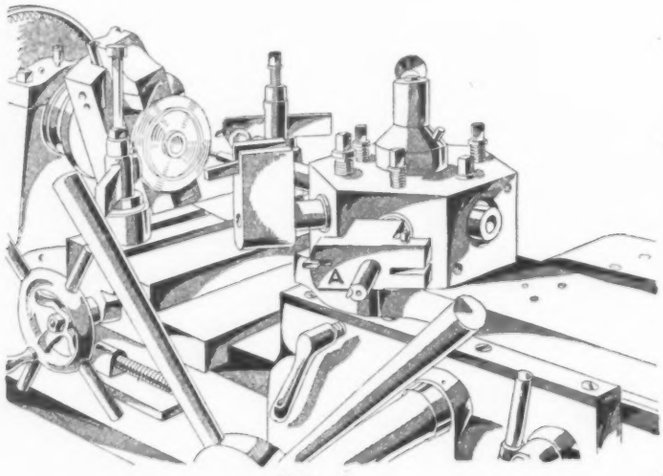


FIG. 6

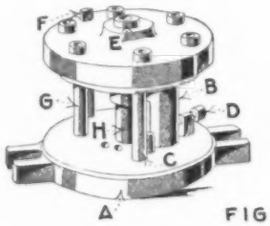


FIG. 7

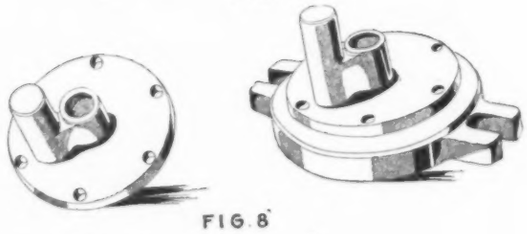


FIG. 8

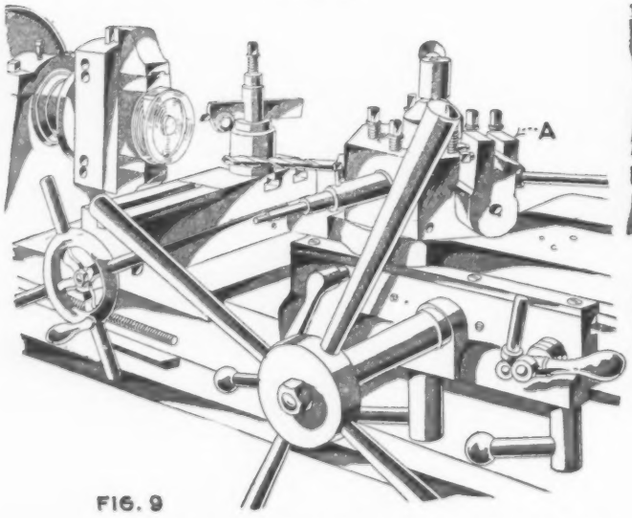


FIG. 9

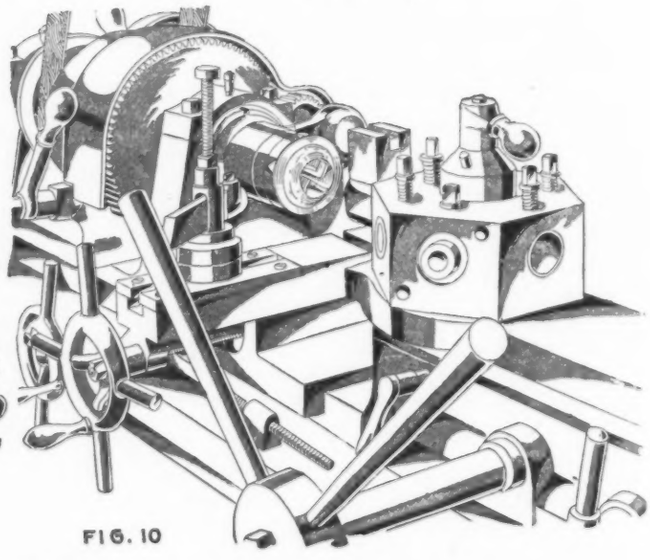


FIG. 10

FIGS. 6 TO 10. OPERATIONS ON COVERS AND IMPELLERS OF VALVELESS LUBRICANT PUMP

Fig. 6—Roughing operations on cover casting. Fig. 7—Jig for multiple-drilling screw holes. Fig. 8—Counterboring jig Fig. 9—Set-up for turning, drilling, boring and reaming impellers. Fig. 10—Finishing impellers

then tapped out with the tap shown. Both the drill and the tap are held in a Magic quick-change chuck, shown between them.

The casting is now placed in another jig similar to the drilling jig, and the cover holes are tapped on the machine shown in Fig. 5. This machine is made by the Evans Stamping and Plating Co., Taunton, Mass., and a boy taps the holes almost as fast as he can handle the work.

The cover casting is first placed in a two-jawed universal chuck fitted with false jaws, as shown in Fig. 6. The front tool on the cross-slide roughs off the cover seat, and the rear tool roughs off the face of the narrow ring. The shaft hole is next rough-bored, and then the flange is finish-turned. The finish-boring and facing are done with the tool *A*, after which the center hole is finish-reamed.

The cover screw holes are drilled with a multiple head in a jig, shown in Fig. 7. The casting is located in this jig by slipping the bored center hole over a pin set into the center of the base *A*. The part *B* is then butted against stop *C* and locked by means of thumb-screw *D*. The cover holding the drill bushings is then placed over the center pin *E*, being located by means of the hardened piece F, which fits into a slot in the jig cover. Pins like *G* and *H* brace the casting directly under the drill bushings. The drilled holes are counterbored with a multiple head in a simple holding jig, shown in Fig. 8.

The impellers require no jigs of any kind. They are first chucked, as shown in Fig. 9. They are then faced off with the cross-slide tool, and the part of the outside diameter not held in the chuck is turned with the turret tool *A*. The center hole is next drilled, bored and reamed.

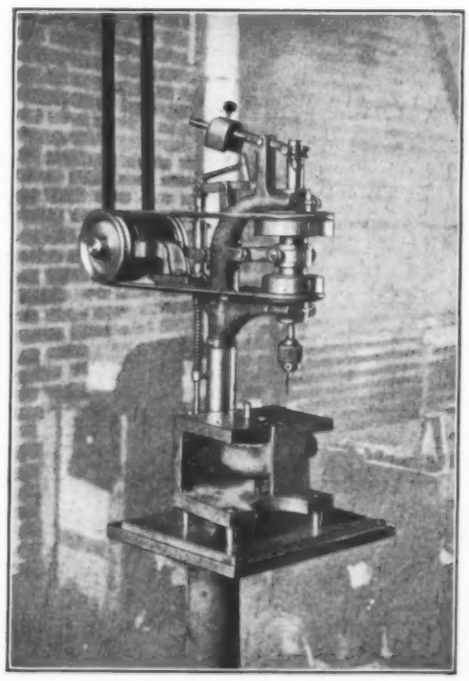


FIG. 5. SCREW-HOLE TAPPING MACHINE

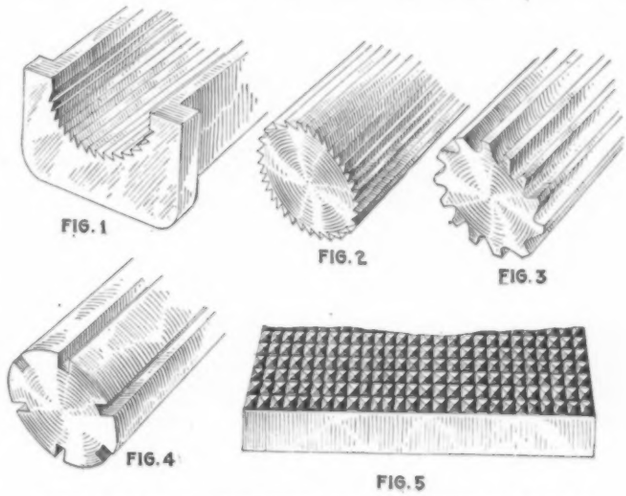
The casting is now reversed in the chuck and the scale knocked off with a cross-slide tool. The finishing is done as shown in Fig. 10, with a formed tool held in the turret. This finishing is performed after the drive shaft has been pressed into place.

Indefinite Shop Terms

By Frank C. Hudson

I'm not much of a stickler for high-browed language, and most of the talk about syntax and prosody, whatever they may be, is all Greek to me. But I do like to know what a man is talking about when he writes an article or a letter, and this isn't always easy when we look over some of the names we give things in and about the shop.

When a man tells us he "scored" a bearing, we usually imagine he means that it is "cut" or "chewed up," "roughed up" or even "galled," depending upon what



PARTS EASILY CONFUSED BY INDEFINITE TERMS

part of the map we happen to hail from. And yet he may not mean that at all. He may mean that he cut small "scores," or grooves, lengthwise of the bearing so that it can wear down evenly, as was often done in railway roundhouse repairs in the days of adjustable side-rod brasses, as shown in Fig. 1. This illustration is exaggerated of course, the scores being made with a half-round bastard file.

In this case either "scored" or "grooved" is probably correct, and yet either (especially the first) might easily be misunderstood to mean one of the other terms mentioned. Yet if this same sort of grooves appeared on the outside of a piece, as in Fig. 2, we should unhesitatingly call them by the entirely different name of "knurling," if the grooves were shallow, or probably "fluted" or "grooves," if they were deeper. If they are rounded at the bottom, as in a reamer or tap, Fig. 3, we naturally call them "flutes," while if they assume a rectangular shape, as is found in many automobile transmission shafts, Fig. 4, they are "splines."

I am not objecting to this usage in the least, because "flute" and "spline" have a very definite meaning to most of us. It is only when the spline becomes a "keyway" or "featherway" in some quarters that confusion again creeps in.

The term "galled," while not very common, is probably clear to most of us as meaning a surface which has been abraded by contact. This probably comes more from the galled horse, however, than from our acquaintance with Shakespeare's "galled jade" of ancient fame. But "scored," though often used in connection with a "cut" or damaged bearing, is also frequently used as an equivalent to "checkered" and may cause confusion in this way.

Fig. 5 shows what I called "checked" or "checkered," although it does not always present a sharp point. A pistol grip is a good example. Some call it "cross-grooved," which is not confusing at any rate, but plain "grooved" seems inadequate if not actually misleading.

Small Wheel of Sheet Steel

For a majority of the ordinary jobs requiring several press operations a number of simple dies are generally better than a compound die or even certain forms of follow dies. A set of simple but effective dies used for making a small steel wheel from sheet metal is here shown. Many tool makers would have attempted to use compound dies, thereby adding greatly to the cost of making and operating, without obtaining any better results. These dies were made by the Gem City Machine Co., Springfield, Ohio, and the various steps in the making of a wheel are shown in Fig. 1. Here *A* represents the first blank, *B* the forming, *C* the blanking out between the spokes and also the rivet piercing. An assembled wheel, with a rubber tire in place, is shown at *D*.

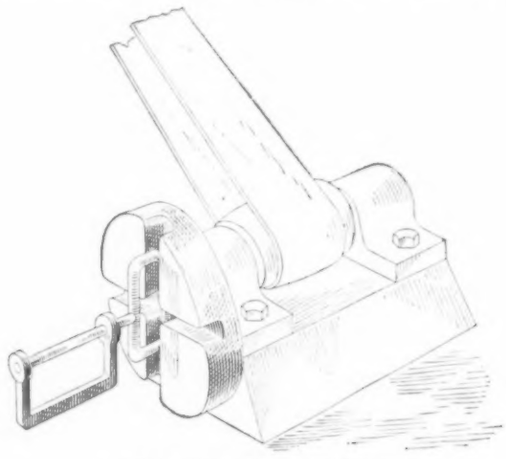
The first blank is 6 in. in diameter, made from steel $\frac{1}{16}$ in. thick. An $\frac{11}{32}$-in. hole is pierced in the center of the blank, as shown. This is done because any attempt to draw the hub without this hole would result in tearing the metal. The first pierced hole is reamed out to $\frac{1}{2}$ in. in diameter before the drawing and forming operation, in order to remove metal that might be crystallized at the edges and to provide clean, smooth metal. The blank is then placed in the die shown in Fig. 2 and the hub drawn down to a depth of $\frac{17}{32}$ in. and $\frac{7}{8}$ diameter, as the rest of the blank is formed for the spokes and rim.

The next operation is to blank out between the formed spokes, which is done in the die shown in Fig. 3. This is a simple blanking die with a stripper plate. Fig. 4 shows the die that pierces the rivet holes. The pieces like *A* are hooked-over pieces for holding down the spokes, the work being laid on the die and put under these hooks by a twisting motion that also brings the spokes over the piercing dies.

Neat Clevis Assembler

By F. W. Buerstatte.

The fixture illustrated shows a method of rapidly assembling clevises. The parts necessary are a chuck, two bearings, a driving shaft and a pulley. The chuck is bored to fit the shaft and fastened to it with setscrews.



A NEAT CLEVIS ASSEMBLER

It is provided with proper grooves, or recesses, into which fit loosely the male halves of the parts to be assembled. The clevis and pin are then put together and placed in the chuck, which when rotated with the belt, screws the parts together, saving considerable time in assembling.

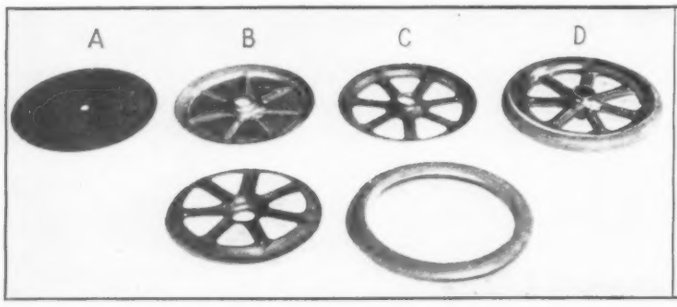


FIG. 1. STEPS IN THE MAKING OF A STEEL WHEEL

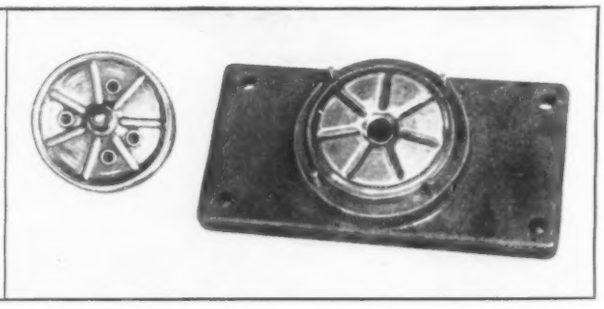


FIG. 2. THE DRAWING AND FORMING DIE

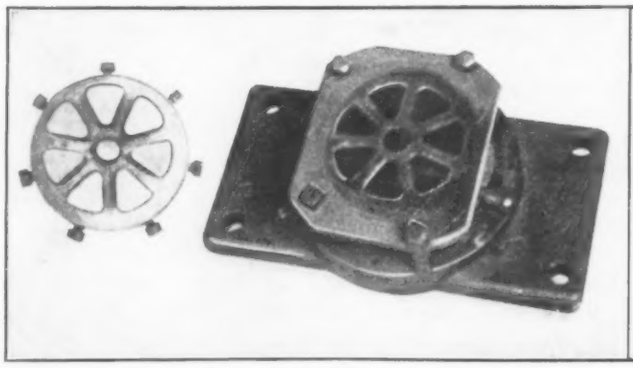


FIG. 3. DIE FOR THE THIRD PRESS OPERATION

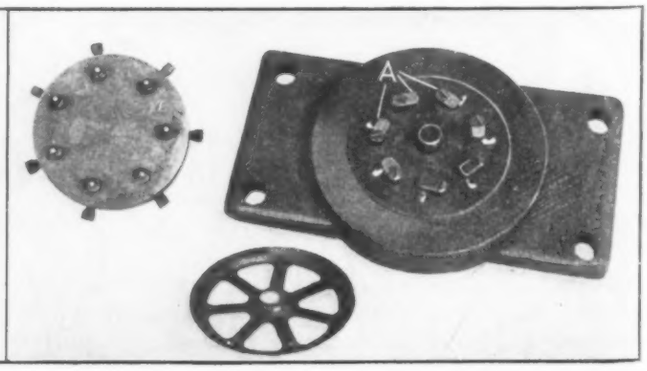


FIG. 4. RIVET HOLE PIERCING DIE

Manufacturing Rifle Cartridges--II*

By G. R. Smith

SYNOPSIS—After the cartridge case has been drawn to its full length, as described in the first article on this subject, on page 881 of Vol. 43, it passes through a number of interesting operations, among which are included trimming to length, heading, turning, indenting, tapering and mouth-annealing.

During the drawing operations the metal at the base of the cartridge has been diminished but slightly from its original thickness of 0.080 in., leaving sufficient stock for the heading, turning and indenting. The turning is usually done on automatic turning lathes, which have a capacity of some 5,000 cases per hr. When these lathes are equipped with fountain feeds, one man is able to operate three or four machines and secure a total output of from 180,000 to 190,000 cases per day of 10 hr.

In some plants girl operators are used for this class of work, while in others it is considered more advisable to use men. For example, at the Essen Works in Germany until the outbreak of the present war, male operators were used exclusively on this work. It is of interest to note that in the small-cartridge department of that noted gun and ammunition plant are found many of our American presses. With slight exceptions their procedure is an almost exact copy of what is in use in the better plants in this country.

Trimming the Case to Length

The open end of the cartridge, which is left rough from the last draw, is trimmed on a full-automatic, magazine-feed trimming machine. In the particular cartridge here described the length is made $2\frac{3}{16}$ in. in this operation. The head-turning operation consists in putting a small groove around the head of the case, so that the extractor of the rifle may take hold of the shell after it is fired. This operation is sometimes done after heading and indenting, and sometimes before, but the two operations are consecutive, whichever one comes first. Automatic lathes are used for the grooving operation.

The heading operation flattens out the bottom or head of the case. Heading is performed on either semi-automatic or full-automatic machines, the latter being desirable in a plant having as high a production as the one I am describing. In some cases both heading and indenting are done at the same time, when the production is about 60,000 cases per day of 10 hr.

Cartridges are loaded with many different charges, such as black powder, semismokeless, dense smokeless and the like. These charges differ so much in characteristics—amount used, density, rapidity of combustion, chamber pressure, etc.—that a number of different primers must be provided. Therefore the primer hole, which is pierced through the head of the cartridge during the indenting operation, is of a great variety of sizes, depths and shapes. Tools for this operation will stand up for some 1,000,000 or more cases, with proper care. The only lubricant used is a little lard oil on the punch occasionally.

*Previous installment appeared on page 881, Vol. 43.

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Much has been written about the impracticability of combining successive die processes on cartridge-case work, but in spite of this I recently saw in operation a press that blanks and cuts in strips, redraws the case four times, heads, indents, and stamps the caliber size on the head before the case is ejected from the machine. This press was running at 100 strokes per min. and doing a high grade of work.

After the case is blanked and cupped in the first die, it is carried by an automatic finger arrangement to the second die, where it receives the first draw, which increases its length $\frac{3}{8}$ in. The same style of finger arrangement carries it to a third die, where the second draw is done while the metal is still warm from the first draw. This process is repeated on the fourth draw, the metal growing warmer at each drawing, which does away with the necessity of annealing between operations. The fifth die, used on the fourth draw, brings the case to its final trimming length.

The heading, stamping and indenting operations are done from the bottom of the press in two operations. When the ram of the press is down at dead center, holding the case rigid in the die, a punch actuated by a set of cams strikes an upward blow on the head of the case and performs its operation of either heading and stamping or indenting. The stock is fed from the roll and the scrap rolled up again.

This machine is a built-up press of remarkable design and is used mostly for cases of the shorter length. One operator can attend four of these machines, as shown in the group in the layout of the press room on page 881. The finished product from a machine of this type needs only to be trimmed, mouth-annealed and tapered.

Mouth-Annealing a Quick Operation

Before the case can be tapered, it has to be annealed at the mouth end, without, however, annealing the head. This operation is done very rapidly, one machine being sufficient to anneal all the cases that one shop can make. There are various styles of annealing machines. The one that I will describe is a simple affair consisting of a chain arrangement that carries the case through a series of gas flames. It is rigged upon a common work bench. Blocks of cast iron are attached to the links of the chain, and three or four holes are drilled into the blocks. These holes hold the cartridges as they pass through the flame and are made large enough so that when the chain runs over the wheel at the end of the bench, the cases will drop into a box truck.

As many gas flames as are required to do the work may be put on an apparatus of this kind. Since the thin walls of the cases heat up rapidly, the chain may run at a good rate of speed and an enormous production be taken care of with this simple arrangement. It is only necessary to bring the case to a dull red to anneal it sufficiently for the tapering operation.

Tapering is done on a ratchet dial-feed reducing or tapering press. In this operation the case is held in the dial and passes under two or more punches, receiving as many taperings as required to bring it to size before it is ejected from the dial. Three reducings are generally

required to bring the full taper from the head down to size at the mouth. This press runs at from 100 to 110 strokes per min. and is driven by a 2- or 3-in. single-ply loose belt, so that if the dial clogs or anything happens, there is not power enough to do serious damage.

Another process of tapering consists of passing the cartridge case through a set of rollers, something on the style of a roller beading machine. The reducing press runs at 110 strokes per min. and gives a production of 50,000 or 60,000 pieces per day of 10 hr. A little lard oil is used as a lubricant to keep the work from wearing or scratching.

There is one point that is very interesting and, so far as I know, entirely new to most readers—that is, the markings on the head of the United States cartridge. In the Government arsenals many of the army cartridges, more especially those loaded for advance field use and for scouting parties, are being marked in a peculiar way. The caliber size is stamped on the head of the cartridge, together with the letters U. S. A. or U. S. N. In addition to these there are other peculiar markings, such as O.F.O., V2, V4, etc. These are code symbols, that when used by an advance guard or scouting party, convey to those coming behind quite varied meanings. After the cartridges are fired, the empty cases are dropped in roads in conspicuous places and in the path of the advancing army; a set of letter combinations is used to indicate road conditions, the proximity of the enemy, and the like. A call for reinforcements, double-quick march of the main army and no end of important directions of immediate and vital value can be conveyed simply by the empty shells left behind. It is one of Uncle Sam's original and valuable ideas.

Details of Locating and Clamping Fixtures

By R. W. Beckman

A standard adjustable wedge stop for use in drill jigs is shown in Fig. 1. This stop is used directly under a drill, *A* representing the base of the drill jig. The bushing *B* is driven into *A*. The adjustable bushing *C* comes up against the work.

The finished boss on the work is set up against a solid stop. As the other boss is rough, it is evident that the dimension *K* will be different on each piece that necessitates the adjustable wedge stop. *D* is a dust cap to keep working parts clean; *E* is a sliding cover that acts as a washer and also keeps the dirt out of the slot. The wedge *F* operates the bushing *C*. The wedge *F* goes into the side of bushing *C* and not under the hole, allowing the dirt and chips from the drill to pass through the clearance hole in bush *C*. A knurled nut *G* tightens the wedge and keeps it from moving once it is in place. *H* is a little pin in the nut which strikes against the pin *I* and keeps the nut *G* from coming off and getting lost. A small pin *J* works in a slot and keeps the washer *E* from turning. The pin *L* keeps the wedge *F* from coming out in the direction of the arrow.

This stop was designed for very light and thin work, and it was necessary to have something very sensitive. After experimenting with different adjustable stops for about three years we finally adopted this design, and it has proved so good that I am sure other readers of the *American Machinist* will find it useful.

A form of holding-down clamp which we have found useful on small drill jigs is shown in Fig. 2. This clamp is very simple and easy to make. The guide pin is tight in the lid, and the clamp is prevented from falling off by the pin in the groove shown.

Fig. 3 shows a quick-acting clamp used in the lid of a small steel drill jig. The screw (which is of regular screw stock, case-hardened) fits a right-hand thread in the lid and a left-hand thread in the clamp. The clamp carries the guide pin by this case, being a loose fit in the lid to the clamp from turning. It is evident that when the screw is turned right-hand it will go down

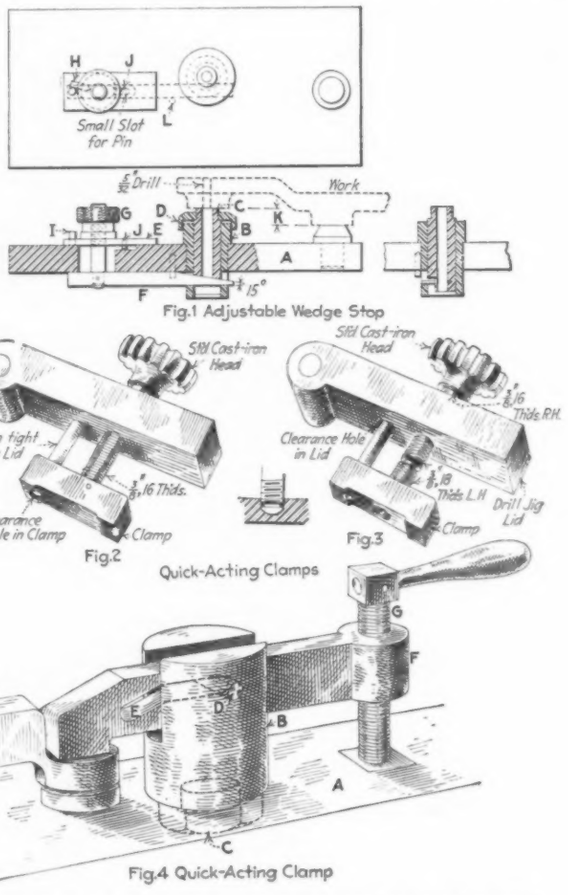


Fig.1 Adjustable Wedge Stop

Fig.2

Fig.3

Fig.4 Quick-Acting Clamp

DETAILS OF LOCATING AND CLAMPING FIXTURES

through the lid, and the left-hand threads will also force the clamp down. This double action makes the clamp work very quickly, and by making the threads with a fine pitch the vibration will not loosen it. It works twice as fast as an ordinary screw clamp and has given entire satisfaction during the past year.

Another quick-acting clamp used on profile and small milling fixtures is shown in Fig. 4. The body *A* carries the cold-rolled stud *B*, which is a driving fit and is also held by a nut *C*. This stud has a slot in it to carry the clamp *F*. The stud *B* also carries the pin *D*. The slot *E* works on the pin. When the screw *G* is loosened, it can be pulled back with the same motion of the hand as that which unscrews the clamp. The clamp rises automatically, on account of the angle of the slot *E*. This clamp is made in very many different sizes and is extensively used in our shop.

Letters from Practical Men

Transforming a Spinning Lathe into a Screw Machine

The piece shown in Fig. 1 has been bought in large quantities, as it is an article used in our manufacturing. Due to war orders, the prices were advanced and shipments delayed so I suggested making the pieces ourselves and of steel instead of brass. Having no automatics or screw machines, I decided to change over a metal-spinning lathe for the work.

Fig. 2 shows how it was changed. A new spindle was made as at *A*, threaded at one end to receive chuck collar *B*; the other end received the clutch fingers *C*, as shown. A 1-in. hole was bored through the spindle. The spring chuck *D* has a taper of 16 deg. To close the chuck, clutch lever *E* is moved to the left, the fingers pushing sleeve *F*, which is a ¾-in. pipe turned on the outside to fit the hole loosely, thus closing the spring chuck. Chuck collar *B* is made adjustable. *G* is the driving pulley.

The changes on the other end to suit requirements consisted in making a taper socket *H* to hold the drill and to secure the spindle from turning, which was done by drilling a hole in the casting, not quite through, and inserting a ¾-in. rod passing through pulley *I* and fitting in keyway *K*. The rod was put in place and then the spindle with the pulley dropped over it, the rod being just long enough to secure a free sliding movement of spindle *L*. In this way nothing was required to secure the rod in position.

The tool slide *M*, which allowed only one side for a tool, was changed as shown in Fig. 3, the dotted line showing the original shape. The operation is as follows: The bar is pushed up to stop *N*, the tool slide being brought to the middle position, and the spring chuck closed. The tool slide carrying the forming tool (in front) is brought to adjustable stop *O*, thus forming the piece.

The drilling is now done, the drill being operated by the foot lever of the machine. This lever is arranged so that a force great enough to break the drill cannot be applied. The movement of the drill is adjusted at *P* and is brought back by a spring, not shown. Lever *R* is now raised, bringing the tool slide forward, and with it the cutting-off tool secured in the back, not shown. The boring tool is so constructed that while it forms the piece at the end of the bar it turns the ⅜-in. size of the next one to $\frac{13}{32}$ in., thus allowing a very narrow cutting-off tool. This saves stock. An oil pump keeps a steady stream of oil on the work. Within a few minutes the machine is changed to its original purpose, only one spindle having to be changed and the ¾-in. rod in pulley *I* removed. The whole alteration was made at a cost of $21, not including oil pump, and in production the machine equals a screw machine.

C. F. Hahn.

New York, N. Y.

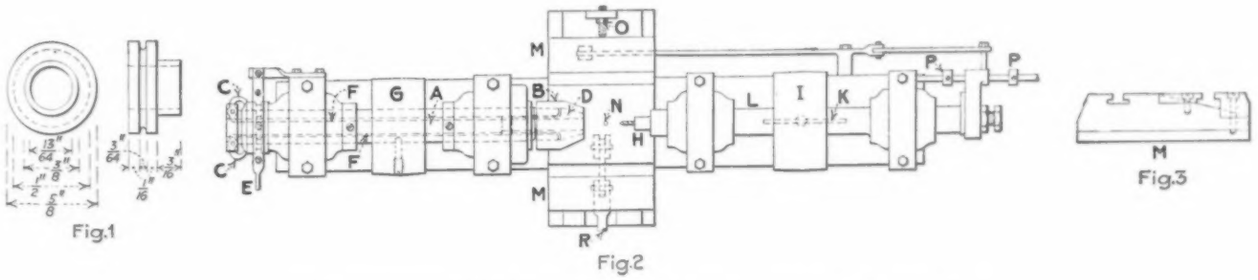
Turning and Threading an Axle Sleeve in One Operation

On a bearing sleeve of malleable iron, for use in adjusting the pinion in an automobile rear axle, it is necessary that the outside diameter and the thread on the barrel run concentric with the inside of the bore within a limit of 0.0015 in. The former way of getting this result was by rough and finish-turning on a lathe mandrel and then threading on a thread miller. This method required a lot of attention to keep the pieces within limits.

The accompanying illustration shows the set-up for an accurate and rapid process of completing the entire operation at one setting. An adapter *A* is screwed on the nose of the lathe spindle. A tool block *B*, carrying one finishing tool *C* and roller stop *D*, is fastened on the cross-slide of the compound rest. The tool block *E*, carrying the finishing tool *F* and chaser *G*, is fastened to the lathe carriage separate from the block *B* and is moved only as the chaser wears.

An air cylinder is fastened on the back end of the lathe spindle and operates the drawbar *H*, which carries a slotted washer *I* to permit the rapid removing and inserting of the pieces. This bar also has a removable pin *J* to push the work off the adapter.

The casting *K* is placed upon the adapter and held firmly by the drawbar, collar and air cylinder. The tool block *B* is brought up to the work until the stop roller *D* comes in contact with a ground shoulder *L* on the adapter. This keeps all the lost motion of the cross-feed screw from interfering with the accuracy of the setting of the tool. Limit graduations are also noted



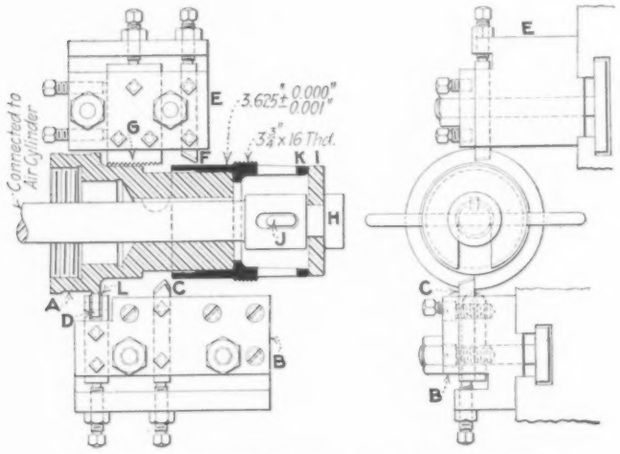
TRANSFORMING A SPINNING LATHE INTO A SCREW MACHINE

as a check and to guard against undue pressure on the roller stop.

A carriage feed of 0.020 in. per revolution of work and a surface speed of 180 ft. per min. are used with a cutting compound.

The finish-turning tool *F* is carried in a block separate from the finish tool *C*, to avoid any increase of pressure on the block *B* while turning the diameter of the barrel, 3.625 in. The finish-turning tool *C* is backed away from the work when the thread shoulder is reached. The lead screw is then engaged, the chaser *G* is carried across the work and the operation is completed. By reversing the air piston the casting is removed and the lathe carriage moved to the starting point before another casting is placed upon the adapter.

The castings are rough-turned, faced and chamfered on an adjoining lathe fitted with an air cylinder and adapter, and come to the finishing operation with 0.040 in. stock to remove from the diameter. The finish-turning



TURNING AND THREADING AN AXLE SLEEVE

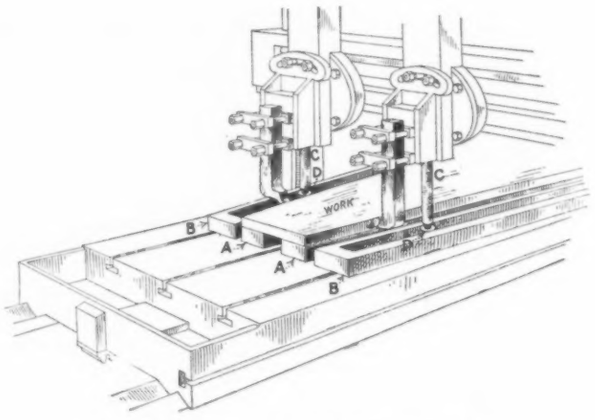
tool *C* is inverted so as not to stop the lathe when engaging the chaser *G*.

On the roughing operation the castings are completed at the rate of 29 per hr.; the finish-turning and threading is at the rate of 28 per hr. The chaser holds its edge from 3 to 5 days with one grinding and can be ground until it is but ¼ in. thick at the front. It is then annealed and recut at a small expense, thus reducing the cost of up-keep on tools.

Flint, Mich. CHARLES E. HENDRICKS.

Planing a Wedge-Shaped Part

In the illustration is shown a wedge-shaped casting the sides of which were to be finished. A widened planer was used, and owing to the size of the work it was not possible to set it up on one side at an angle and face the other side, as the work would not pass under the crossrail of the planer. The work was therefore placed on raising pieces *A* and clamped to the table of the planer in the ordinary manner. Strips *B* were fastened to the table of the planer, and their centers cut out. The strips were located at an angle on the table corresponding with the taper of the work. Studs *C* were screwed into the two saddles on the crossrail. The studs carry at their lower end a roller *D*, held by a collar fastened to the stud. These rollers run in the openings in the two strips. A uniform cut was taken on the side of the work, as the rough casting was tapered to correspond with the finished dimensions. During the operation the crossfeed screws were disconnected from the two heads on the crossrail,



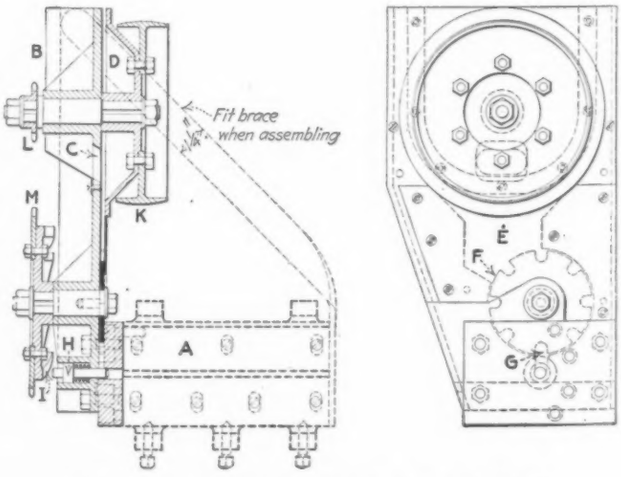
MACHINING A WEDGE-SHAPED PART

and the rollers running in the openings in the strips cause the cutting tools held in the two heads to move along the desired path to machine the face of the work properly. W. C. MAKLEY.

Birmingham, Ala.

A Positive Automatic Grinder Feed for Small Roller

An automobile concern in Milwaukee had to grind the outside of rollers $\frac{7}{16}$ in. in diameter and $\frac{5}{32}$ in. thick in large quantities. It started out to feed these rollers by hand in the grinding fixture *A*. This was too slow an operation and a positive automatic feed was designed,



POSITIVE AUTOMATIC FEED FOR GRINDER

which was later attached to the grinding fixture. This materially reduced the cost of labor, as one boy can operate three or four machines.

The unground rollers are put in a pocket *B*. From here they drop through an opening *C* in the cast-iron base into a hopper *D*, which keeps the rollers moving and drops them in their flat position into a pocket *E*. If

this pocket is filled, no more rollers can drop, the remaining ones staying in the hopper.

A wheel *F*, having notches fitting the rollers, takes them from this pocket one by one and drops them in a slot *G*. Here a pin *H*, operated by a cam *I* and a spring, feeds the rollers in the grinding fixture *A*, taking the place of the boy previously operating the machine.

The cam *I* is shaped in such a way as to assure a slow forward and quick backward motion of the feeding pin *H* coming next to a continuous feed.

The hopper is driven by pulley *K*, which is screwed directly to the hopper *D* and keyed to a shaft on which the sprocket *L* is mounted. The latter is connected by a chain with sprocket *M*, which drives the feeding wheel *F* and cam *I*, which operates the feeding pin *H*. The feeding mechanism is very simple and reliable, as can be seen from the illustration.

P. BALDUS.

Milwaukee, Wis.

Making a Duplicate Core Box

In replacing a worn-out core box, I have found the following method a great saving in time.

Fig. 1 represents a pistol core. In making a new core box, in place of adding stock onto the halves of the forms for allowance in finishing up the face of the two halves,

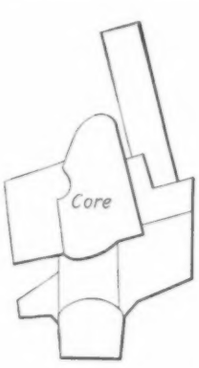


FIG. 1. A PISTOL CORE

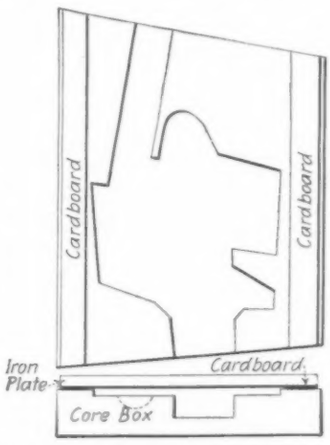


FIG. 2. MAKING THE CAST

I place two strips of cardboard on each half of the old core box, as in Fig. 2, place a strip of metal between, then pour each half with white metal.

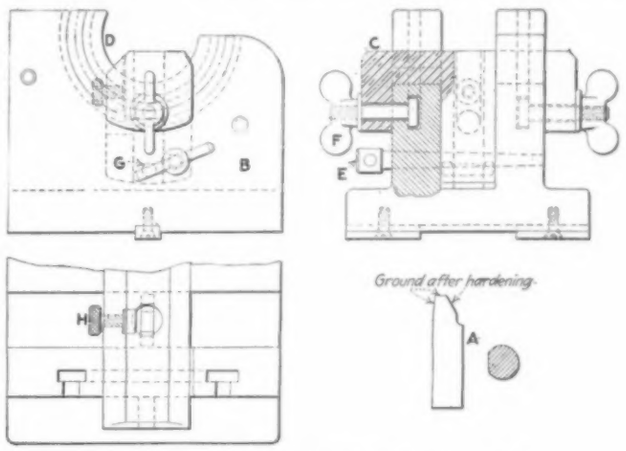
The two halves have enough stock to allow for finishing. A fin is left all around the form, but it can easily be removed. I next take the two forms and place them on a flat plate, pour the plaster over the form and have a perfect model with stock allowance for finish.

Naugatuck, Conn. A. E. HOLADAY.

Three-Position Locking Pin Grinding Fixture

The tool-steel locking pin shown at *A* had to be ground on three surfaces after hardening as shown, and these surfaces had to bear an exact relation to each other.

The fixture used is shown in the illustration. It is composed of a body with two projections finished on each face and a steel block *C*. This block is turned to fit the bored surface *D* of the casting, and by a taper pin *E* it is located in the three positions necessary to produce the proper shape of the pin. After it is located, it is clamped by two T-bolts *F*. The piece is slipped into the hole in



THREE-POSITION GRINDING FIXTURE

the block against a pin *G* and clamped by the screw and shoe *H*.

P. P. FENAUX.

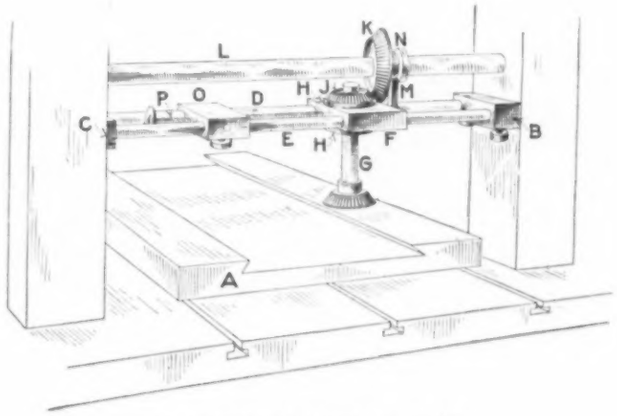
Newtonville, Mass.

Machining Dovetail Slot

At *A* in the illustration is shown a part in which it was desired to mill the dovetail shown. A planer large enough to handle this work was not available, and a horizontal boring, drilling and milling machine was used with the home-made vertical milling attachment described.

This particular machine had power crossfeed to the two columns carrying the spindle and outboard bearing, and the two crossfeed screws for traversing the columns were connected together so as to move the spindle and the outboard bearing crosswise together. Owing to the dimensions of the work, which measures several feet in width and length and only a few inches in thickness, it was not desirable to set it up on end. It was therefore clamped to the bedplate of the boring machine.

The plate *B* has two holes drilled in it and is bolted to the face of the main column of the machine, while the



MACHINING DOVETAIL SLOT

plate *C* with two similar holes drilled in it is bolted to the housing of the outboard bearing. Two rods *D* and *E* are held in the plates *B* and *C* by means of setscrews, and the casting *F* has two holes drilled in it to fit the rods *D* and *E*, on which it is mounted, being a sliding fit.

Another hole was drilled in the casting *F* at right angles to the two holes for the rods *D* and *E*, in which was placed the vertical spindle *G*. This spindle is held in the casting *F* by means of two collars *H* fastened to the spindle. A bevel gear *J* is keyed to the vertical spindle, and another bevel gear *K* is mounted on the bar *L*, turning with the latter by means of a spline. This bar was mounted in the regular spindle of the boring machine and supported at the other end in the outboard housing. The plate *M* is bolted to one end of the casting and engages with the part *N* fixed to the bevel gear *K*. The casting *O* is also mounted on the two rods *D* and *E*, being held from moving on these bars by means of setscrews.

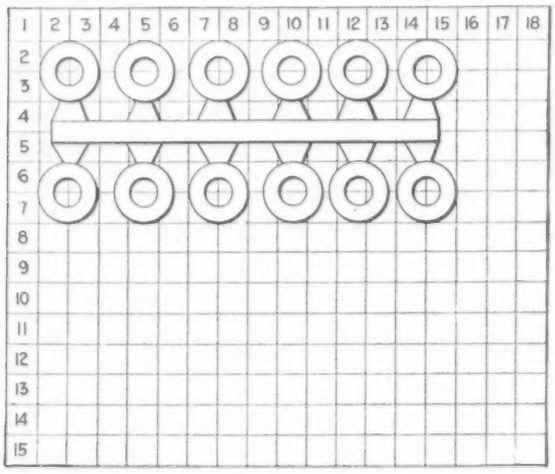
A hole is tapped in *O*, in which the feed screw *P* is placed; the other end of the screw *W* is fastened to the casting *F*, the connection being such that the screw is free to revolve in the casting *F* but will move the latter along the rods *D* and *E* when rotated. A handle is fastened to the screw *P* for turning it. By means of this screw the vertical spindle *G* may be moved along the two rods *D* and *E* as desired. As the casting *F* is moved on its rods, the bevel gear *K* is also moved on the bar *L* by means of the plate *M*. A suitable milling cutter was fixed to the bottom of the spindle *G*. W. C. MAKLEY.

Birmingham, Ala.

"Checkerboard" To Be Used for Laying Out Patterns

This device is used in laying out loose patterns to be gated, to ascertain the size of flask required, and for patterns already gated.

The illustration shows a gated pattern laid on the



CHECKERBOARD FOR LAYING OUT PATTERNS

board, allowing 1 in. of sand all around. This pattern takes a flask 8x16 in. A. E. HOLADAY.

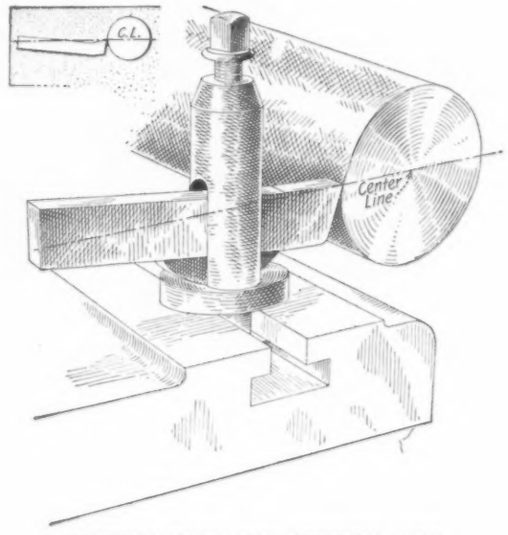
Naugatuck, Conn.

Cutting Off Steel in the Lathe

Much has already been said about parting steel in the lathe, and poor cutting lubricant is generally blamed for chattering and digging in of the tool. The cutting lubricant used has an effect on the length of time the tool may be used before resharpening, but has little to do with either chattering or digging in.

If the parting tool, when used in either the engine lathe or bench lathe, is inclined as shown in the sketch, with the cutting edge set at the center line, no trouble will be experienced in parting stock.

While lard oil or a good cutting compound is preferred when parting steel, machine oil will help preserve a tool that is properly located in the lathe. The stock being



SETTING TOOL FOR CUTTING OFF

parted may be run at the same speed as would be used for ordinary turning, and once the cut is started the tool should be fed in without stopping.

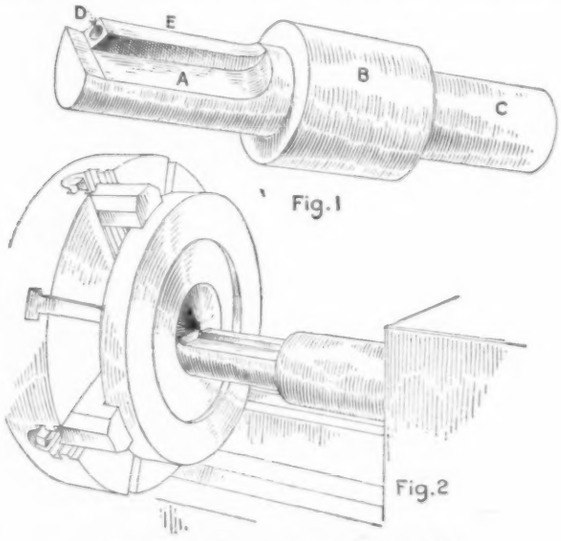
If the operator stops feeding for a moment while the piece is in motion, the tool, if slightly dulled, will produce a glazed surface that is hard for the tool to enter.

Newark, N. J. GUSTAVE A. REMACLE.

Saving Steel in Drill Design

The drill shown was designed with the intention of reducing the cost of high-speed steel.

A shows the drill proper, which is really a short bit fitting in the holder *B*. The shank of the holder fits into



SAVING STEEL IN DRILL DESIGN

the turret of the automatic screw machine. *E* shows a raised portion of metal on one side of the blade to take the $\frac{3}{16}$-in. oil hole *D*. Fig. 2 shows how the drill is used. About one-third as much high-speed steel is used.

Dayton, Ohio. RAYMOND W. BECKMAN.

Discussion of Previous Question

Counting Gear-Wheel Teeth

On page 1044, Vol. 43, H. L. Fletcher, writing on the counting of gear-wheel teeth, says, "Mark the space and you cannot go wrong." Now as there are as many spaces as teeth in a gear, it would seem to be as easy to go wrong in marking the one as the other.

But if one trains one's self to mark a tooth and count the spaces, then the chances of going wrong are materially lessened; but one must make a practice of it. It must be firmly fixed in one's mind; and always before counting the teeth of a gear, repeat the slogan, "Mark a tooth and count the spaces."

If, however, the gears are those in regular use, as the lathe change gears or those of the universal milling machine, they should not be counted more than once. They should then be marked with both the number of teeth and the pitch. Attention to this apparently small matter may easily prevent a costly mistake.

Some manufacturers of gear wheels have the number of teeth cast in, but many cases have been unreadable. The best way to mark the gears referred to is to stamp the numerals on both hub faces, taking care to remove any burr that may be thrown up. Large type should be used.

Most mechanics wipe the faces of the hub as well as the bore before assembling, so that they will hardly fail to observe the tooth number of the gear they are putting in use, if it is marked as here suggested.

Bournbrook, Birmingham, England. F. R. MANN.

[A common method used in the shop when counting gear teeth is to place a finger on a tooth and then count away from it. Then going around the gear, count all the teeth, including the tooth where the finger is placed.—Editor.]

Machining a Large Albro Wheel in a Small Lathe

On page 1062, Vol. 43, Mr. Mullin tells how he cut a worm of the Albro type in an engine lathe. He says that by this method he got "a very good job." How he got it is more than I can understand.

Let the figure represent the set-up for the job. I will use his lettering as far as possible. D represents the center of the milling-machine vise and AF the tool; FG is the link connecting the end of the tool with the carriage.

If his illustration is assumed to be to scale, the work occupies about 48 deg. of the circumference of the gear. Therefore in the extreme position of the tool (AF) the angle FDM equals 24 deg. and the line DY equals DF, sin 24 deg., or 11.25 sin 24 deg. = 4.575 in.

Assume the lathe to turn through one revolution. The carriage advances 1 in., throwing the tool into the position A_2F_2. DX then equals 4.575 in. — 1 in. = 3.575 in., and the angle $F_2DM = \sin \frac{3.575}{11.25}$ in.

In other words the angle F_2DM equals the angle whose sine is 3.575 in. ÷ 11.25, or 18 deg. 30 min. A 1-in. movement of the carriage when the tool is at the end of its swing turns the tool through an angle equal to 24 deg. — 18 deg. 30 min., or 5 deg. 30 min.

When the tool is in the position A_3F_3, the point F_3 is ½ in. from the center line. A 1-in. movement of the carriage moves the tool to A_4F_4 through an angle equal

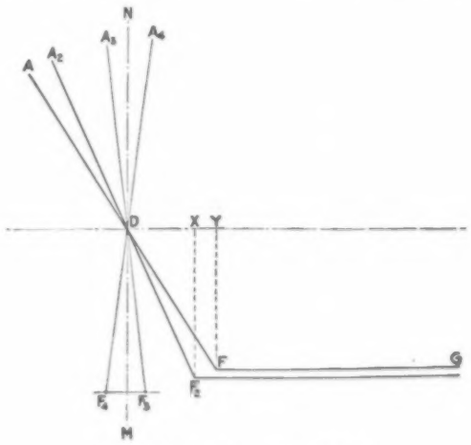


DIAGRAM OF TOOL PATH

to twice the angle whose sine is 0.5 ÷ 11.25, or 5 deg. 6 min.

The difference in the two movements amounts to 5 deg. 30 min. — 5 deg. 6 min., or 24 min., which on the 25-in. circle of the gear is equal to a difference of 0.086 in. This means that the thread on the worm is 0.086 in. thicker at the end of the worm than in the middle, which would not produce "a very good job"!

Lafayette, Ind. V. A. TRASK.

Effect of Oil in Cutting Off

The article by I. Kempt, page 936, Vol. 43, should be carefully read and remembered by all mechanics. The effect due to changing the liquid used as a coolant in machine operations has not received anything like the attention that it deserves. Mr. Kempt tells us that changing from a poor oil to a good-grade lard oil made all the difference between bad and good results in cutting off.

As I have recently had several opportunities of realizing the beneficial effects that may be obtained by changing the coolant, perhaps a recital of some of these will be both informative and interesting. That a change from oil to water-compound is an advantage when machining certain classes of steel is fairly well known among shop men, yet too often this simple fact gets overlooked.

The three following experiences will serve to illustrate the effects of such a change. The first of these occurred on a broaching machine. Here a set of spline broaches that had previously worked well began to act badly by dragging pieces out of the end of the work. After the

broaches were sharpened, they still tore the work. Knowing the benefit of using a thinner liquid for broaching, we changed from oil to a water compound. The result was entirely satisfactory; so much so that whenever we find broaches beginning to drag—this is usually on very tough heat-treated material—we change from oil to compound.

Another occasion when compound succeeded where oil had failed was on a Potter & Johnston automatic. The job was a spherical seat for a rod end used for steering an automobile. This work had been done previously on a turret lathe with success, yet when it was put on the automatic, with practically the same tooling, poor results were obtained. The finishing tool—a hemispherical balling tool with five cutting edges—dragged very badly.

A little thought soon showed that the solution—from previous practice—was to use a coolant. When this was done, the hemispherical tools produced the excellent finish we were accustomed to.

Yet another example is taken from a recent occurrence on a Cleveland automatic. A small die head, used for producing studs, began to cut anything but a correct thread. After trying the usual remedies, such as testing the alignment of the die head and changing the lead of the chasers, and still getting poor results, the operator pumped the oil from his machine and substituted water compound. Then the threads were everything desired.

These three examples will serve to show the effect of using a thinner coolant. The name of the compound used has not been mentioned, because there is no reason to believe it is better than others. In fact, we have every reason to suppose that any strong solution of soda water, with which a small quantity of oil had been thoroughly incorporated would have given better results.

Guildford, England. WALTER G. GROOCOCK.

Lubricating Lathe Centers

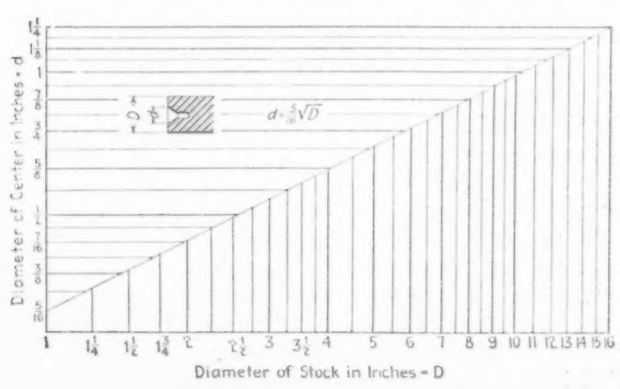
The question of lathe centers, raised by Mr. Prince on page 866, Vol. 43, is a question of correct proportion between the diameter of the center and the diameter of the work. Lubrication is of course necessary to all bearings, but it is essential first to provide sufficient bearing surface. With larger work and heavier cuts the pressure on the centers increases; and to keep the pressure a minimum per unit area, the centers must be increased.

Carl G. Barth, while with the Bethlehem Steel Co. in 1900, concluded from a large number of observations that the diameter of the centers varies according to the square root of the diameter of the work. It is with the permission of Mr. Barth that I give his empirical formula based on these observations; $d = C\sqrt{D}$, in which d equals diameter of centers, D equals diameter of work and C is a constant. Values of C between $\frac{5}{16}$ and $\frac{3}{8}$ have been used with very satisfactory results.

The accompanying chart, giving the diameter of centers for a range of work from 1 in. to 16 in. in diameter, was plotted from Mr. Barth's formula, using $\frac{5}{16}$ for C. These sizes of centers have been found to give satisfactory results.

S. J. AURELIUS.

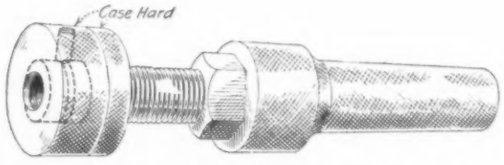
Chicago, Ill.



DIAMETER OF CENTERS FOR TURNED WORK

Adjustable Stop for Automatic Screw Machine

At our plant we have 150 Cleveland automatic machines working on bar stock. I have found that although just such a stop as shown on page 80, Vol. 44, by John Hoffman is good, the end of it will wear—from the stock revolving against it when being placed in the machine—



IMPROVED STOP FOR AUTOMATIC MACHINE

and the accurate lengths of the pieces to be machined are lost.

The accompanying illustration shows a similar stop, excepting that it has on the end a loose collar that revolves with the stock. Our machines will run indefinitely on the same job, without any readjustment of the stop, and have been in use over four years.

Bridgeville, Penn. ROSS ANDERSON.

Machinist Instruction in the Public-School System

Regarding the time element in trade schools, all will admit that time must be considered sooner or later in the boy's shop life, but very few will agree when to begin. In my experience with boys it has been very evident that a green boy cannot be made to appreciate that a job must be done quickly and be well done or, in fact, what a quick or a good job really is. He knows nothing of shops, life or procedure; and while he may think he is working fast, he may really be traveling in a circle.

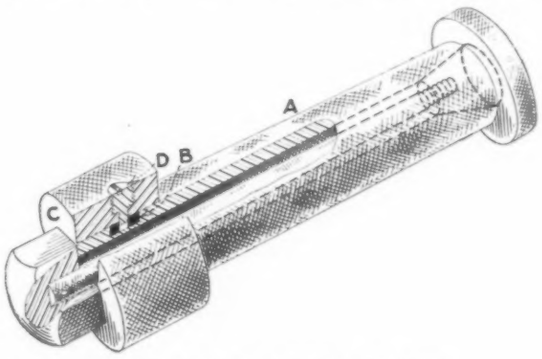
I think the first thing is to teach him what a good job is; that is, let him work on it until he gets a passable job, taking all the time he needs. This is accomplished in some schools by means of fixtures, eliminating all close work until the lesson is learned.

Once the boy can recognize a good job, gradually bring him up to a time limit—generally considerably more than a journeyman would take—but a time that will keep him hustling. If a boy starts out to hurry before he knows what is really wanted, he is much more apt to spoil work. I have seen boys take two weeks on a job at first that they would do in two days a month later.

Westfield, Mass. PAUL T. HARKNESS.

Best Way To Do Certain Things

I was as usual intensely interested in Professor Sweet's article on page 936, Vol. 43, on the "Best Way To Do Certain Things." J. P. Poland's contribution on page 35, Vol. 44, in extension of the same subject and treating of the proper method for discharging collets from spindles, brings to my mind a similar problem in relation to a machine in which the spindle was fitted with ball bearings and the collets were frequently changed by inexperienced help. Here, any pounding on the spindle



METHOD OF EJECTING COLLETS

draw-in rod would quickly destroy the bearing. While the solution of the problem is not as simple mechanically as Mr. Poland's differential screw, it has the advantage of being operated in the ordinary way.

In the illustration the spindle *A* is shown grooved for the split ring *B* and drilled for the end of the screw *D*, which holds the collar *C* from endwise movement in relation to the spindle *A*. The draw rod *E* is pinned to the collar *C*, which is milled on the end for a standard hexagon wrench.

G. C. Herz.

New York City.

Notes on Small-Tool Design

Referring to the article on page 59, by Mr. Wilder, I notice that Fig. 8 calls for a fish-tail cutter such as is used in a Pratt & Whitney spline milling machine, but the illustration is not correct. Cutters used in this machine have straight shanks, the small machine taking $\frac{5}{16}$-in. diameter shanks and the large machine $\frac{7}{16}$-in. shanks. When the diameter of the cutter is smaller than the diameter of the shank, these cutters are made double ended; when larger, single ended. They are as a general rule cut on a 15-deg. spiral. On cutters $\frac{1}{2}$ in. and up, three and four teeth are used, three teeth having been found very satisfactory. Of course there is the disadvantage of not being able to measure the three-tooth cutter after it is once ground.

The point of the tool shown in Mr. Wilder's Fig. 8 is all right where a square corner is required, but stock fish-tail cutters are made up as shown in the illustration, Fig. 1, in which case the tool will cut a slot clear through the work, or it will leave a small bevel at the bottom of the cut.

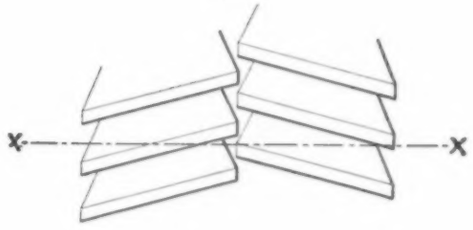
Mr. Wilder shows two cutters, Figs. 2 and 4, in which the hole is threaded to suit the arbor. I do not consider that a thread can be made satisfactorily in a cutter. On gun work the limits on the hole in a cutter are 1 + 0.0005 in., and on the arbor 1 — 0.0005 in., which means a tolerance of 0.0005. I do not see the advantage of threading a cutter over the shell end mill.

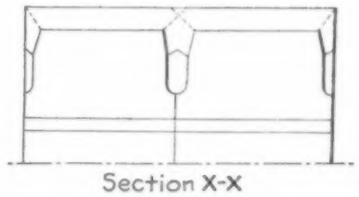
In Fig. 2 I show a pair of spiral interlocking cutters. This design of cutter is desirable when cutting on the outside diameter and sides. By making the cutters this way they may be packed as the sides wear, materially increasing their life; also there is not the drag on one side of the cutter that is bound to occur when there is one spiral, either right- or left-hand.

While Mr. Wilder has given some interesting data as to the number of teeth in comparison with the diameter of the cutter, I would say that there is another matter that enters into this problem. It is a well-known fact that, for gun work in particular, the finer the teeth the better finished the part will look. I have found that with cutters up to and including 3 in. in diameter the circular pitch should be pretty close to $\frac{5}{16}$ in.

Eccentric-relief cutters can be figured about the same way, taking as a pitch circle one-third the difference

Fig. 1





Section X-X

Fig. 2

POINTERS ON SMALL-TOOL DESIGN

between the minimum and the maximum diameters of the particular cutter in question. The gashing cutter should be about 35 deg.

The circular pitch may increase from $\frac{5}{16}$ to $\frac{7}{16}$ in. on cutters 6 in. in diameter.

J. W. Maynard.

Hartford, Conn.

Small-Shop Planers

I have followed J. H. Van Deventer's small-shop series with great interest and believe it to be a valuable contribution to the technical literature of the day.

Referring in particular to the article, "Small-Shop Planers—II," page 889 of Vol. 43, I find the statement, "The center of a planer bed should be set one or two-thousandths higher than the ends," to which I humbly take exception. While the error of one or two-thousandths is not much, it will have a tendency to cause the planer platen to develop a bow at the center. This feature is

therefore undesirable, as it aggravates the usual causes of a bowed planer platen.

As is well understood, the usual causes of a bowed planer platen are, first, the planer platen overrunning the planer bed; and, second, the planer platen is usually peened and stretched on the center of the top surface, as this is the place at which the castings are usually strapped to the platen.

It therefore seems wrong to set the center of a planer bed one or two-thousandths higher than the ends. Probably the best way to set a planer platen is to set it as nearly as possible to a true level and horizontal plane.

Mr. Van Deventer has picturesquely described the old planer in the following words, "These hale and hearty old boys are slow movers, being geared to run between 15 and 20 ft. per min. on the cutting stroke." I find that old planers can be advantageously respeeded to 40 or 60 ft. on the cutting stroke without serious inconvenience or excessive maintenance. However, it is necessary to select carefully a satisfactory means for driving. One method that I have found successful is to replace the usual pulleys with cork-insert pulleys, sometimes cork-insert aluminum pulleys; and I would add, where Mr. Van Deventer suggests using a double belt, a double belt well stitched, which will then give little trouble from stretching.

When possible to respeed a planer by changing the gearing, this method is preferable to changing the size of pulleys, provided the power of the belts is sufficient. The old planer equipped as stated will do practically as good and as rapid work as a modern planer, provided it has received good treatment and is properly maintained.

One of the most interesting features of this same issue of the *American Machinist* was the advertisement of the Cleveland Automatic Machine Co., pages 26 and 27, illustrating the fact that its mechanics get the right tools at the right time, at the right place—and probably in condition to be used—thus eliminating the lost intervals that Mr. Van Deventer has so frequently referred to. Small-shop owners, however, cannot hope to approach the ideal here referred to, but all shops, large and small, should strive harder to approach this ideal.

ROBERT E. NEWCOMB,
Superintendent, Deane Steam Pump Co.
Holyoke, Mass.

What's the Matter with Our Methods of Threading?

I noticed with special interest your editorial on methods of threading and also the subsequent article on page 173, by P. W. Abbott. While there are many good suggestions in this article, it is my opinion, based on 15 years' experience in making and using taps and dies, that some of the statements are misleading.

In the first place, as to the kind of dies best adapted to automatic screw-machine work, it is my opinion that the round adjustable die is the least economical. It is very evident that a round adjustable die that has been made 0.005 in. oversize, lapped to get a high polish, and then adjusted down until it is of proper cutting size will not be round. Therefore, it is practically impossible to make this die cut on more than two lands.

Another difficulty with using round dies, or with using any solid die, especially on material of a tough nature, is that there are as many threads spoiled while the die is coming off as while it is going on. This is due to the fact that, when the die stops cutting and reverses, there is a chip left sticking out in front of each cutting edge. As the die runs off, this chip must be broken off by the cutting teeth that come next in front, if as often happens, the chip does not break, the cutting tooth snaps instead.

The concern with which I am connected has decided, after using all kinds and nearly all makes of dies, to use opening dies wherever it is possible to do so. We are now using them on Gridley four-spindle and Brown & Sharpe automatics, doing work as small as ⅛-in. screws. While it is of course true that some self-opening die heads are not accurate, this is certainly not true of all of them.

It is my opinion that most people do not realize how much depends on getting correct lead. A variation of 0.002 in. per inch of lead is a good deal more serious defect in making a screw than twice that amount in diameter. If the screw is off in lead, it may appear to fit fairly well when it is new; but it will soon wear loose.

We do not consider a saw-tooth lead gage 1 in. long a proper tool for measuring a screw 4 in. long. We use lead gages 4 in. long on 4-in. screws. The screw must fit without any shake whatever, in order to pass inspection.

The lead of the screw is affected not only by the kind of material being cut, but by whether the die is sharp or dull, whether it is properly ground and also by the kind of cutting lubricant used. It is my experience that, contrary to the opinion expressed by Mr. Abbott, if you want to get good threads you must use good oil. We have found the so-called "fancy high-priced oils" the cheapest in the end.

Every tap and die manufacturer, as well as every screw manufacturer, is thoroughly aware that the V-thread is something that we have had "wished" on us. It has no excuse for existing. It not only costs more to make taps and dies and screws with this form of thread, but the taps and dies are not nearly as efficient after they are made. This inefficiency of taps and dies also applies to the Cadillac thread, which is half V and half U.S.S.

It is our experience that if taps are made at least 0.002 in. oversize on the outside diameter and the screws are made at least 0.002 in. undersize on the outside diameter, there will be no binding on top of the thread.

If I was called upon to name the different styles of dies in the order of their efficiency for screw-machine work, I would name, first, the self-opening die; second, the solid adjustable die; third, the spring, or prong, die; and, fourth, as least desirable of all, the round, or button, die. By the solid adjustable die I mean a die on which all the chasers are adjusted radially.

H. E. WARREN,
General Manager, Mac-It-Parts Co.
Lancaster, Penn.

Effect of Varying Sulphur in Basic Open-Hearth Steel

In the reprint of Mr. Unger's paper, published on page 191, an erroneous impression may have been obtained by the substitution of the word "more" for "less" in both the synopsis and summary. The original wording, which should have been retained, was as follows: "The author does not advocate paying no attention to sulphur content of steel, but believes firmly that a steel containing less [not "more"] than 0.100 per cent. is not necessarily bad," etc.

Editorials

Every Man His Own Designer

Two years ago one familiar with American machine tools could walk through a shop and recognize the make of each machine by general and special features, without having to study its nameplate. Since the start of the European War, however, so many new designs have come into being that our old mechanical acquaintances are apparently being pushed into the background by numerous new machine tools that assert in no uncertain terms their ability to "knock spots out of the old fellows." This fact could hardly be expected to escape the notice of machine-shop men, and that it has at least set one man thinking is made evident by the following letter:

What is the matter with the old-established makers and designers of machine tools? It looks to me as if they have been asleep for the last 20 years; for if not, how is it possible that every Tom, Dick and Harry can at a few months' notice bring out a machine tool that will turn out work as fast as, if not faster than, the machines designed by regular machine-tool people?

In the plant where I am employed we have a large contract for shells, and I have observed that several standard makes of machine tools have been put to one side in favor of machines that we have designed and built ourselves, which are more satisfactory. I have traveled about the country quite a bit in connection with my work at this plant, and I have observed the same thing elsewhere.

What I want to know is whether machine-tool builders have been bluffing us all these years. It begins to look like it, when you see built in agricultural-machinery, printing-press machinery and textile-machinery plants tools that apparently hold their own with the old-timers.

A number of others have asked us this same question. Apparently everyone is going into the machine-tool business. Experienced makers and designers of machine tools are not alarmed at the prospect, however. They know that the problem of designing a machine for one special purpose is one of the easiest problems in the mechanical world—that it is not in the least comparable with their far more difficult problem of designing a machine that will be suitable for, and satisfactorily efficient on, a broad range of work.

The designer of a machine for making shells knows what his machine has to accomplish. His problem is written out on the blackboard in plain figures and falls into the kindergarten class. The designer of a general-purpose machine tool has his problem full of unknown quantities and must make a machine that will be efficient on jobs that he has never seen or heard of. One machine corresponds to the laborer whose daily task is confined to the specialized work of digging ditches; the other, to the highly trained tool maker who is able to perform a large variety of high-grade work. An efficient ditch digger is not hard to find, nor is an efficient special-purpose machine hard to design; but years of training must go to make a high-grade tool maker and years of experience into a high-grade machine tool.

The fact that some of these new machines do the work in less time than the old ones has no bearing on the problem. By building a machine with enough rigidity, enough belt power and enough tool lubrication it is possible to reduce any record that has as yet been made. There is not an established machine-tool builder in this country who could not, if he desired, bring out a machine for this special purpose that would equal or surpass, in producing capacity any now being produced outside of the machine-tool field.

The question might be raised as to why they do not do this. Why should they? Machine-tool building plants are working to their capacity and subletting work on their standard lines, which they are best fitted through experience to build and on which they are making a greater profit than they would make by building special-purpose machines.

It is a case of the demand exceeding the supply and of a lack of competition, brought about by unusual conditions that enable almost anything that resembles a high-powered lathe to be sold. When conditions again come back to normal, competition will solve the problem and there will be a good many specialized machines standing idle while the "old fellows" come into their own.

Working for Safety, and Safety in Working

From some quarters the idea has been advanced that safety efforts have been overdone. This sentiment is probably due more to the efficient advertising of leaders in the safety movement than to any particular statistics in the hands of the skeptical of actual safety work accomplished. If any objection is raised by one or another to the use of many and diverse safety appliances, there surely can be no objection, even by the most doubtful mind, to the authoritative words of the commissioner of labor in one progressive state, who recently said that since his state has adopted systematic safety regulations for all shops and factories the number of fatal and less serious industrial accidents has been materially reduced.

After all, the final test that must be applied to any movement of this kind is to establish the results accomplished; and the economic returns due to lower fatality and reduced minor accidents, which are now more readily measurable in dollars and cents than formerly, are apt to be enormously greater than the outlay of a relatively small amount for safety appliances. Of course, abuses on the part of some few factory inspectors must be expected now and then, and sometimes the protection requirements may seem impracticable in terms of the results that follow; but these factors do not change the underlying principle of conservation of life and limb.

To anyone accustomed only to shop conditions of 10 or 15 years ago the recent exhibit of the National Safety Council in Philadelphia was a revelation of the rapidly changed attitude toward the safety of the shop worker. The statistics alone of this active organization were of a surprising magnitude, and those doubting the sincerity of the forces behind the "Safety-First" movement, on entering these spacious exhibits were compelled to leave with respect at least for work thus far accomplished.

Among the most striking features of these exhibits were the devices and aids direct from the industries themselves, bearing testimony to the effectiveness of new methods to educate the foreman as well as the workman to the needs of greater safety; further, the first-aid booth, together with first-aid cabinets used in the plants of various industries, was also of suggestive value; and a booth erected jointly by the University of Pennsylvania and the local illuminating companies contained unusual demonstrations of artificial lighting in its relation to safety. In this last-mentoned booth a number of lathes were installed, each equipped with modern lighting methods; and two shop stairways, with landings, served as a basis for showing good and bad stairway and passageway illumination in their relation to accident prevention.

There can be no reasonable doubt of the fact that exhibits of this kind, supplemented by actual statistical data, have real value and have already served to begin the education of many persons in the basic ideas upon which the safety idea has been built. It is quite true that the continual emphasis of safety on all sides gives a first impression of excessive attention to this feature. On the other hand, personal safety is such a primary instinct to all normal minds that its appeal is direct and positive. It follows therefore that any item in industrial life so closely related to the welfare of the individual, even if often overlooked with resultant accidents, is far less apt to escape notice, if by frequent repetitions each person's attention is directed not merely to safety in the abstract, but to the why and wherefore of each phase of the situation.

If the conservation of the worker means anything at all, it surely is worth the effort that is rightfully being devoted to legitimate safety means; and the evidence on which conclusions are drawn should consist largely of the actual helpful results following any of the numerous efforts now being made.

In this movement the danger of familiarity breeding contempt must be guarded against.

Job-Hunting Technical Unions

Within six months three new technical or engineering societies have been formed in the Middle West. These are the American Association of Engineers, Associated Technical Men and the Engineering and Commerce Efficiency Society of America. The first two have headquarters in Chicago, Ill., the second in Cleveland, Ohio. No one questions the right of any group of men to organize for proper objects. But why have these societies been formed? Is there a temporary situation that their organizers are trying to meet, or are there fundamental needs of engineers that the older societies do not satisfy?

It has been stated that the reason for the upspringing of these three organizations can be found in the fact that in the Middle and Far West there are at present many unemployed engineers. Construction work is at a standstill, there is no immediate prospect of its reviving, and the jobless engineers are in a discontented, downhearted frame of mind. Support is found for this belief in the stated aims and purposes of these societies.

The object of the first mentioned association is stated in article 2 of the constitution, as follows:

> The object of the association shall be to raise the standard of ethics of the engineering profession and to promote the economic and social welfare of the engineering profession.

One means for accomplishing this aim is "by maintaining a service clearing house for its members."

The objects and purposes of the second society are stated thus:

> Whereas, Under the present conditions of the technical profession there exist unintelligent competition, a lack of coöperation and organization, which is resulting in a decreasing rate of compensation among technical men, a consequent low social standing and a general lowering of ethics and honor of the profession from the former high standard;
>
> Whereas, The failure to secure suitable compensation is preventing technical men from development and from discharging their obligations to society and from discharging the position in the social scale to which their professions entitle them;
>
> We, the body assembled, undertake to form an association which will weld together in a common bond of interest all those who may be justly considered as engaged in technical pursuits.

Apparently the third society has fallen directly in line behind its two immediate predecessors. From its code of regulations the following quotations are taken, being the first and last items under the heading "object":

> To promote questions and facts relating to social service, vocational opportunities, scientific and practical information.
>
> To maintain a mutual coöperative service department, a free employment exchange, for the convenience of the unemployed or unsatisfactorily employed members of the society. Notice of all technical or commercial openings to be sent to all members alike, without reservation, except for classification.

All three organizations thus have as one principal aim the hunting of jobs for members. They are after "material results" rather than professional or altruistic benefits. One is strongly reminded of the former Society of Engineer Draftsmen that had an uncertain existence for a few years and finally disappeared through consolidation with some other society with a similar record.

Another object of these societies, gathered from reading their literature—although it is not as boldly expressed as the purpose to help the unemployed or unsatisfactorily employed—is the wish for public recognition of engineers and a true valuation of their achievements. With this wish all engineers will sympathize. But it is very doubtful if any new society is needed to further this object.

All of the older national societies are wrestling with the problem of the position of the engineer in public esteem and during the last year more progress than ever before has been made to bring the engineer into his own. The selection of the Naval Advisory Board from the members of five of the national societies and the plan now being worked out to develop munition committees from members of these same societies are two of the most striking testimonials that have ever been given to the worth and importance of the engineer and engineering in public affairs.

Although all the national societies are formed to further professional objects and not to gain material benefits for their members, each one does help in bringing together would-be employees and prospective employers. The American Society of Mechanical Engineers perhaps does more of this work than any other. During last year it registered over 400 positions and from actual record placed over 100 men. It is impossible to keep the latter kind of record complete; unquestionably more men were helped than the figures show.

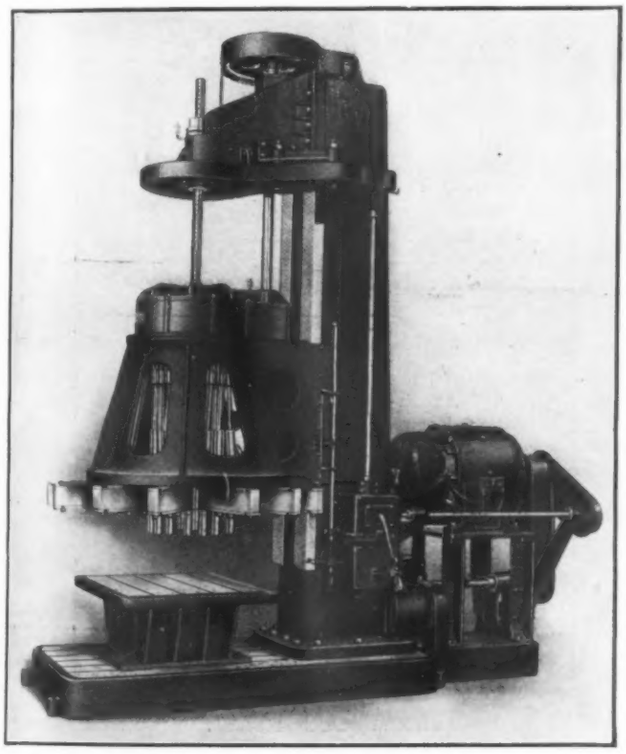
Any man before joining one of these newer societies should ask himself this plain question: Am I furthering the best interests of my profession by joining a society one of whose principal aims is to hunt a job for me?

Shop Equipment News

Multiple Drilling Machine

The special feature of the machine illustrated is the "center feed," the feeding pressure being in the center of the head, directly over the center of the drill layout, thus eliminating any tendency for the head to spring away from the guides on the post under heavy duty.

The head is 40 in. long, giving a long bearing on the post, and the gear chest is over the top of the head, giving



MULTIPLE-SPINDLE DRILLING MACHINE
Capacity, 16 spindles, 2½-in. drills in cast iron

long spindle connections and making a slight angle to the joints. The drive is by countershaft to the cone pulley, or by motor to the same shaft, through one pair of bevel gears and two pairs of spur gears to the spindle gear in the head. The bevel gears are of steel; the gears at the top of the post, of cast iron; and the gears in the head, of steel. The driving shaft to the head is 3¼ in. in diameter and runs at nearly the same speed as the drills. The feed screw is 3 in. in diameter, 2½ threads per in., Acme thread, and is fixed in the head, the nut being rotated. This nut is of bronze, the lower 10 in. being threaded, while the upper end is bored slightly larger than the screw, providing an oil pocket to insure good lubrication. The nut has a solid head on the lower end to take the feeding thrust and a large nut and check nut at the upper end to take the weight of the head, with a large ball thrust bearing at each end.

There are two changes of feed, obtained by shifting the clutch lever on the lower part of the feed gear box. The feed is taken from the main cone shaft through spur gears (cloth pinion), through change gears to the worm and worm gear on the vertical shaft through the feed gear box, and spur gears near the top of the post to the feed nut. Quick motion of the head is obtained by a belt from the counter, or by silent chain from the motor, through bevel-gear reverse to the quick-motion sleeve on the vertical shaft. The feed clutch connects to the worm gear by a tooth clutch and to the quick-motion sleeve by a friction clutch.

The feed lever has a catch that locks it in place when the feed is thrown in. The catch is released by a knock-off rod, the rod first compressing a spring on top of the feed lever, so that when the catch is released, the feed clutch is thrown out, the quick-return clutch is thrown in, and the head is automatically raised to the up position. Quick motion down is obtained by reversing the quick-motion lever.

The bevel gears in the post also have ball thrust bearings, one of which supports the vertical shaft in the post, as do also the driving gear at the top and the driving and spindle gears inside the head. The spindles are equipped with ball thrust bearings. Roller bearings are used at both ends of the cone shaft and the vertical shaft in the post. All other bearings are bronze bushed.

The machine shown is the latest addition to the line made by the Baush Machine Tool Co., Springfield, Mass.

Automatic Hydraulic Lathe

The machine illustrated has been designed and built by the Lombard Governor Co., of Ashland, Mass. The spindle is belt driven through one pair of reducing gears, and in addition to rotating it advances longitudinally in its bearings, thus providing the feed movement. The power for feeding is secured through hydraulic oil pressure that acts upon the spindle as a piston. Oil is admitted through a needle valve, the opening of which is controlled by flat bar cams mounted on a control drum having a longitudinal movement synchronous with that

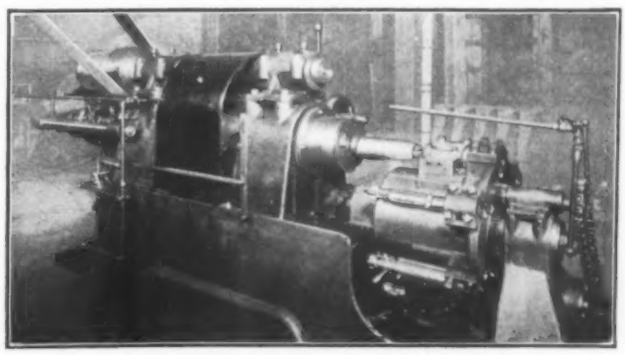


FIG. 1. AUTOMATIC HYDRAULICALLY CONTROLLED TURRET LATHE
Maximum swing, 12 in.; length of feed, 11 in.; turret drum, 14 in.; tool circle diameter, 19½ in.

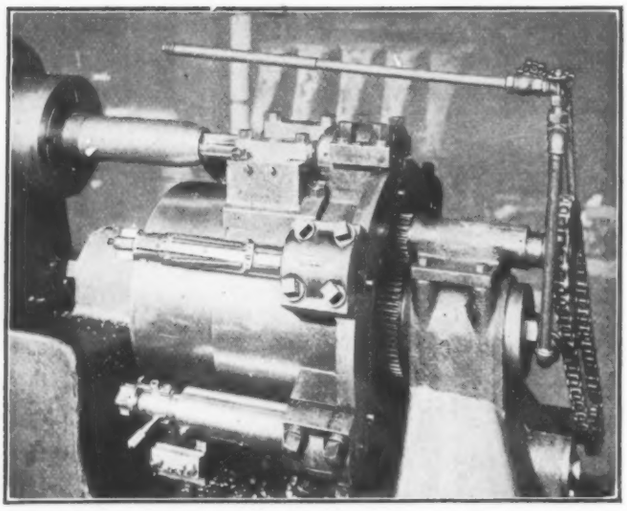


FIG. 2. TURRET AND TOOLS AT WORK ON 18-LB. HIGH-EXPLOSIVE SHELL

of the spindle and indexing with the turret, so as to present a different cam position for each turret position.

The turret is mounted on a horizontal axis and has no longitudinal movement. In the machine that has been constructed there are six turret positions, but in future machines it is proposed to add one more.

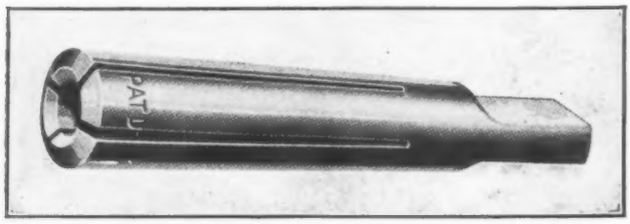
The machine is equipped with a split collet chuck for holding bar stock, corresponding to the rough diameter of British 18-lb. high-explosive shells. This chuck is operated hydraulically by means of a diaphragm that draws the collet back upon its tapered seat. The machine is geared to give a spindle speed of 120 r.p.m., and the feeds can be regulated from less than one-thousandth of an inch per revolution to one-quarter inch. A variable or increasing feed can be had by adjusting the slope of the cam bars. The revised design of this machine shows provision for a stop-valve that is to cause a dwell at the end of the feed movement when desired. The spindle return speed approximates 20 ft. per min. The weight of the machine is 6,000 lb.

As applied to machining 18-lb. British high-explosive shells, this machine has performed all the boring, tapping and outside turning and nosing operations, with the exception of band grooving, base finishing and cutting off, in 15 min. On this work two shells are turned from each piece of stock, one end being chucked while the other is operated upon.

Tap-Driving Chuck

The tap chuck shown is made of one piece of hardened steel entirely devoid of screws, pins or other separate devices.

The tap is held by the body of the shank and is not dependent on the square on the tap to make it run true.



TAP-DRIVING CHUCK MADE OF ONE PIECE

The chuck has a standard Morse taper and is readily inserted in the drill spindle. The construction takes care of a variation of $\frac{1}{32}$ in. in the tap-shank diameter.

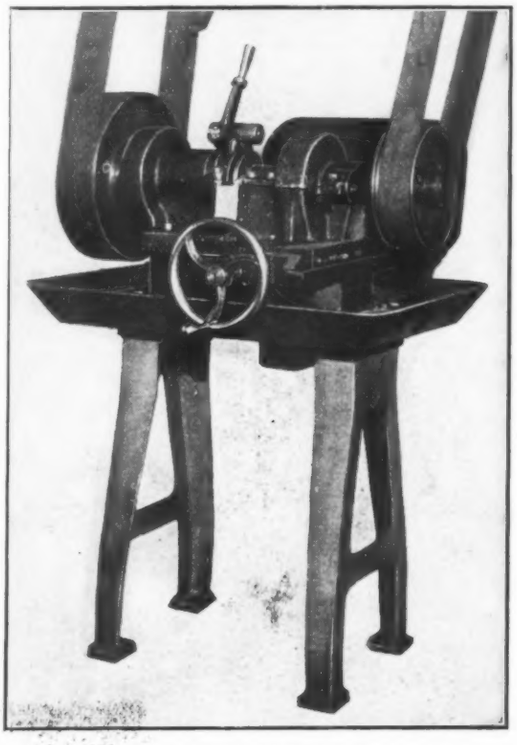
In this design the tap becomes a taper shank tool and is consequently conveniently handled and requires little room.

The tool is made by Scully-Jones & Co., Chicago, Ill.

Shell-Plug Miller

The machine shown was designed for turning and milling the threads of gas-check plugs for high-explosive shells.

All the operations of milling the thread, turning the outside diameter of the plug and facing it complete are performed in one chucking. The machine is equipped with oil pump, quick draw-in collet and automatic stop on all feeds.



SHELL-PLUG MILLER

This machine is a late product of the A. R. Williams Machinery Co., Toronto, Canada.

Grinding-Wheel Guard

The entire guard shown, with the exception of the adjustable trap at the top, is made of boiler plate. The adjustable trap at the top is a steel casting held by large screws. The outer plate is hinged and can be opened to allow changing of wheels or cleaning out.

The guard has a box formation at the bottom, so arranged that the iron, or steel, and heavier particles from the abrasive wheel remain in the bottom of the guard, while the lighter particles, such as would otherwise float in the air, are removed by a suitable exhaust-pipe connection at the back. With this arrangement the exhaust pipes do not easily become clogged, and less damage is done to the fan. The sediment is easily

GRINDING-WHEEL SAFETY GUARD
Sizes regularly made for 16-, 18-, 20- and 24-in. wheels

removed from the guard by opening the door and cleaning with a shovel.

This guard is a recent product of the Ransom Manufacturing Co., Oshkosh, Wis., and is shown attached to one of its grinders.

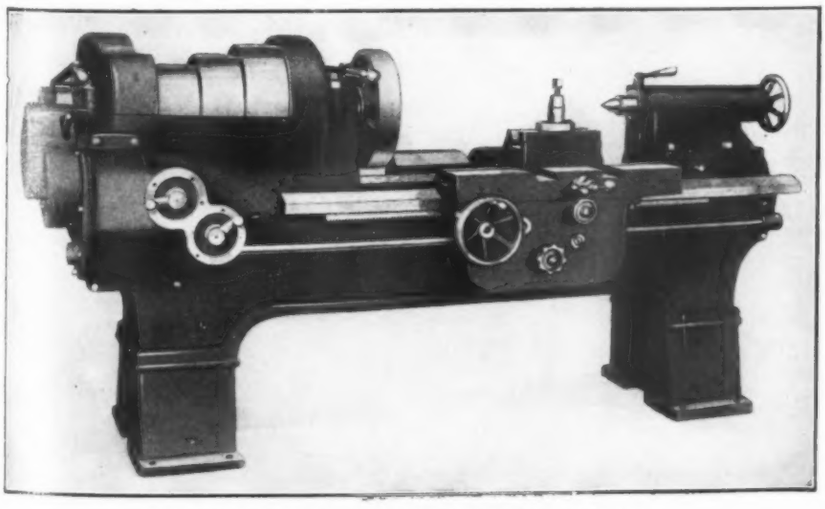
Heavy-Pattern Manufacturing 22 In. Lathe

While the lathe shown was designed along what have come to be considered single-purpose lines, it possesses practically all the features of the regular engine lathe, the screw-cutting feature being the only important omission.

The bed has an unusual vertical depth, and the rear carriage bearing is flat; the front bearing is a wide V. The headstock is of drop-brace construction, with the outside housing brought up to the center line of the cone. The cone has three steps—11, 13 11/16 and 16 3/8 in. in diameter for 5-in. double belt. The headstock is equipped with double back gears, giving ratios of 3.17 to 1 and 11 to 1. There are 18 spindle speeds, ranging in geometrical progression from 11 to 335.

The carriage has a bearing 32 in. long on the bed, which is 20 3/4 in. wide and is clamped down at the rear with a special device designed to insure easy movement of the carriage without backlash. The apron is of the box type, so constructed that all shafts have a bearing at both ends. Both feeds are operated by frictions. The feeds are positive geared through a quick-change gear box, giving six changes—8, 16, 24, 32, 64 and 96 turns to the inch.

The machine weighs about 5,000 lb. and is a recent product of the Economy Engineering Co., Willoughby, Ohio.



HEAVY-PATTERN MANUFACTURING LATHE
Swing over ways, 22 in.; length of bed, 8 ft.; swing over carriage, 13 in.; accommodates between centers, 3 ft. 1 in.

Military Reading for Civilian Engineers

By authority of the Secretary of War and in response to frequent requests, the following suggested list of reading is issued by the War Department for the information of civilian engineers desiring to inform themselves on military subjects.

These references have been selected, first, with a view to giving to engineers unfamiliar with the art of war a general survey of that subject, an understanding of which is the first essential to insure successful application of engineering knowledge and resources to military purposes; and second, with a view to setting forth, as far as practicable, the ways in which engineering is applied to military purposes and the means provided therefor.

Both military art and military engineering are progressive, and a considerable part of the latest and most detailed information published is available only in service journals of our own and foreign armies. This is particularly true of technical details of seacoast defense (including submarine mining), of field artillery, of military aviation, and the influence of these on military engineering. It is believed, however, that the fundamentals of each subject are well covered by the references given in this list. While the list is long, the relative importance of the various works is indicated, the suitable comments on each are included, so that persons using the lists of references may be able to select those which particularly interest them.

The references under each subject are generally divided into two groups, the first containing the more essential references, and the second those suitable for persons desiring to inquire further into the subject.

Suggestions looking to improvements of the lists will be gladly received.

A. MILITARY POLICY, CONDUCT OF WAR AND MILITARY HISTORY

Group 1

1. OFFICIAL BULLETIN Vol. 1, No. 2, Office of the Chief of Staff, Washington, D. C. (Especially pp. 21-39.) Publisher: Army War College, Washington, D. C. Free. (An official outline of the theory under which our forces are to be organized and administered.)

2. MILITARY POLICY OF THE UNITED STATES. Upton. May be obtained from Supt. of Docs.[1]; paper, 50c.; cloth, 65c. (A most valuable and comprehensive review of this subject.)

3. FIELD SERVICE REGULATIONS, 1914. May be obtained from Supt. of Docs.; 60c. (A condensed official statement of principles, methods and details of military operations.)

4. ELEMENTS OF STRATEGY. Fieberger, Publisher: U. S. Military Academy, West Point, N. Y. May be obtained from Book Dept.[1]; 75c. (A short outline, with historical illustrations.)

Group 2

5. CONDUCT OF WAR. Von der Goltz; translated by J. Dickman, Hudson Publishing Co., Kansas City, Mo. May be obtained from Book Dept.; $1.70. (The standard work on this subject, covering generally the same ground as 4, but more abstractly and elaborately.)

6. ON WAR. Clausewitz; translated by J. J. Graham; 3 vols.; K. Paul, Trench, Trubner and Co., 1908. May be obtained from Book Dept.; $6.60 (including postage and duty). (The greatest classic on the subject; a complete analysis of the phenomenon of war, and profound discussion of the mechanism thereof. Written early in the nineteenth century, it is still the foundation of modern military theory.)

6½. THE NATION IN ARMS. Von der Goltz. May be obtained from Book Dept.; $2.50. (An excellent modern work on war; less elaborate but more readable than Clausewitz.)

7. AMERICAN CAMPAIGNS. M. F. Steele; 2 vols. Publishers: Byron S. Adams Publishing Co., Washington, D. C. May be obtained from Book Dept.; $4.50. (In addition to careful historical surveys of all the campaigns from the Colonial Wars to the Spanish-American War, these lectures give extensive and valuable comments as to the military principles.)

8. A STUDY OF ATTACKS ON FORTIFIED HARBORS. Rodgers; Proceedings Nos. 111, 112 and 113, United States Naval Institute, Annapolis, Md.

9. LESSONS OF THE WAR WITH SPAIN. Mahan. Publishers: Little, Brown & Co., Boston, Mass. May be obtained from Book Dept.; $2. (Of special importance, as showing the true relation between our coast defense and our navy.)

10. REPORTS OF MILITARY OBSERVERS ON THE RUSSO-JAPANESE WAR. Part III, J. E. Kuhn. May be obtained from Supt. of Docs.; 60c. (In addition to an account of operations, this report contains valuable information as to fortification and siege work, organization and equipment.)

11. ORGANIZATION AND OPERATION OF THE LINES OF COMMUNICATION IN WAR. Furse, 1894. Publishers: Wm. Clowes & Sons, Ltd., London. (An old but comprehensive survey of this subject, with much historical information.)

B. PERMANENT FORTIFICATIONS

Group 1

(The references given cover chiefly the principles and general features of this subject; the details are mostly printed in unavailable form, either in service journals or in confidential documents. References to some of the former can be furnished, if desired.)

12. REPORT OF NATIONAL COAST DEFENSE. (Taft) Board, 1906. May be obtained from Army War College, Washington, D. C. Free. (The official project for harbor defenses of the United States. On account of progressive obsolescence of seacoast defenses, this project has been, or is being, modified, but still sets forth clearly the fundamentals.)

Group 2

13. LECTURES ON SEACOAST DEFENSE. Winslow. Publishers: United States Engineer School, Washington Barracks, D. C. Price, 50c. (Much of these lectures relates to technical details, and a considerable part is now obsolete.)

14. PERMANENT FORTIFICATIONS. Fieberger, 1900; United States Military Academy, West Point, N. Y.; $1. May be obtained from Book Dept. (While rather old, this work gives a simple presentation of the fundamentals on its subject, including an historical outline. A revised edition will soon be published.)

15. FORTIFICATIONS. C. S. Clarke. Dutton & Co., New York; $4.50. May be obtained from Book Dept. (A treatise on the same lines as 14.)

16. PRINCIPLES OF LAND DEFENSE. Thuillier, 1902; Longmans, Green & Co. May be obtained from Book Dept.; $3.83. (A valuable work, covering the principles of both field and permanent fortifications.)

C. ORGANIZATION, EQUIPMENT AND DUTIES OF ENGINEER TROOPS

Group 1

17. FIELD SERVICE REGULATIONS, 1914. (See A. 3.)

18. TABLES OF ORGANIZATION, 1914. May be obtained from Supt. of Docs.; 25c. (These tables represent—subject to modification and within the limits of existing law—the approved policy of the War Department with regards to organization.)

19. OFFICIAL BULLETIN, Office of the Chief of Staff, Vol. 1, No. 4 (Appendix 4). Use of Engineer Troops. Publisher: Army War College, Washington, D. C. Free. (An official statement of the principles which should govern in the use of engineers, with practical suggestions.)

20. DUTIES OF ENGINEER TROOPS IN A GENERAL ENGAGEMENT OF A MIXED FORCE. Burgess. Publisher: United States Engineer School, Washington Barracks, D. C.; 25c. (Obsolete in some respects, particularly organization, but excellent in general scope.)

21. GENERAL ORDERS NO. 6, WAR DEPARTMENT, 1915. May be obtained from the Adjutant General, United States Army, Washington, D. C. Free. (Prescribes the training of Engineer troops.)

[1]The following abbreviations are used: Supt. of Docs., Superintendent of Documents, Government Printing Office, Washington, D. C. Book Dept., Book Department, Army Service Schools, Fort Leavenworth, Kan.

Group 2

22. STUDIES IN MINOR TACTICS. Army Service Schools, 1915. May be obtained from Book Dept.; 50c. (The principles of Minor Tactics are set forth by solution of a series of problems.)

23. TECHNIQUE OF MODERN TACTICS. Bond & McDonough, 1914; Banta Publishing Co., Menasha, Wis. May be obtained from Book Dept.; $2.55. (This work covers, in a very specific way, the principles of tactics for all arms, a general knowledge of which is essential for engineers.)

24. OPERATION ORDERS. Von Kiesling; translation. May be obtained from Book Dept.; 50c. (A lucid exposition, by use of assumed cases, of the operation of highly trained troops of all arms in various phases of battle.)

25. ENGINEER UNIT ACCOUNTABILITY MANUAL. May be obtained from Supt. of Docs; 5c. (Official lists of standard equipment supplied to Engineer battalions and companies.)

26. ORGANIZATION OF THE BRIDGE EQUIPAGE OF THE UNITED STATES ARMY, 1915. (Revised edition just going to press.) (Includes description of equipage and regulations for pontoon drill.)

27. OFFICERS' MANUAL. Moss; Banta Publishing Co., Menasha, Wis.; $2.50. May be obtained from Book Dept. (Treats of routine duties of officers, customs of the service, army organization, etc.)

28. MANUAL FOR COURTS MARTIAL. May be obtained from Supt. of Docs.; 50c.

D. FIELD ENGINEERING

(Military field engineering at the front differs from ordinary engineering work in the field, it being generally simpler, of a rough-and-ready character, and especially because of the limited equipment which can be taken along with the advance of an army and because of the necessity of working in strict subordination to the military situation. In rear of the army, on the contrary, conditions are very similar to those governing ordinary engineering operations, and civilian organization is suitable, subject to directions by the higher military staff. Little attempt is made in works on military field engineering to treat of general engineering methods.)

29. FIELD FORTIFICATION. Fieberger, 1913; John Wiley & Sons, New York. May be obtained from Book Dept.; $1.90. (In addition to technical details, this work gives valuable historical illustrations of the principles of this subject.)

30. FIELD ENTRENCHMENTS, SPARE WORK FOR RIFLEMEN. John Murray, London. May be obtained from Book Dept.; 40c. (A very up-to-date little work, especially on details.)

31. NOTES ON FIELD FORTIFICATION. Army Field Engineer School. May be obtained from Book Dept.; 30c.

32. ENGINEER FIELD MANUAL. Professional Paper No. 29, Corps of Engineers, United States Army; 2d addition, 1909, 500 pages. May be obtained from Supt. of Docs.; $1. (A very complete official pocketbook for engineer officers in the field, containing many tabular and technical data, as well as brief outlines of principles and methods. The subjects covered are: Part I, Reconnaissance; Part II, Bridges; Part III, Roads; Part IV, Railroads; Part V, Field Fortifications; and Part VI, Animal Transportation. A new revision of the manual is contemplated, but will not be ready within a year. The portion of the manual relating to field fortification, being somewhat obsolete, should be considered in connection with either 30 or 31 above. The portion relating to railroads is largely superseded by 35 below.

33. NOTES ON BRIDGES AND BRIDGING. Spalding. May be obtained from Book Dept. (A small pamphlet on military bridging.)

34. MILITARY TOPOGRAPHY FOR MOBILE FORCES. Sherrill, 2d edition; Banta Publishing Co., Menasha, Wis., 1911. May be obtained from Book Dept.; $2.25. (Besides matter given in ordinary textbooks on surveying, this work gives in detail the special methods of sketching developed in the army for rapid military mapping.)

35. MILITARY RAILROADS. Connor; Professional Paper No. 32, Corps of Engineers, United States Army. Supt. of Docs.; 50c. (Intended to cover general administration of existing railroads for military purposes and the handling of railroads by military personnel in the advance sections where railroads cannot be operated by their regular civilian organizations, or where new railroads are required in the immediate vicinity of the army. Revised edition soon to appear.)

36. NOTES ON MILITARY EXPLOSIVES. Weaver; J. Wiley & Sons, New York; 1912. May be obtained from Book Dept.; $2.20. (Elementary notes on this subject will be found in the Engineer Field Manual and other references cited. This work is more elaborate.)

E. MISCELLANEOUS

37. REGULATIONS FOR THE ARMY OF THE UNITED STATES. Supt. of Docs.; 50c.

38. THE "VOLUNTE5R LAW," approved Apr. 25, 1914; Bulletin No. 17. War Department, 1914. May be obtained from the Adjutant General, United States Army, Washington, D. C. Free.

39. GENERAL ORDERS. NO. 54, War Department, 1914. May be obtained from the Adjutant General, United States Army, Washington, D. C. Free. (Covers examination of candidates for commissions as officers of volunteers.)

40. GENERAL ORDERS NO. 50, War Department, 1915. May be obtained from the Adjutant General, United States Army, Washington, D. C. Free. (Amends General Orders 54, 1914, as to examination of candidates for commissions in volunteer engineers.)

41. TREATISE ON MILITARY LAW. Davis; J. Wiley & Sons, New York. May be obtained from Book Dept.; $5.38.

42. ELEMENTS OF MILITARY HYGIENE. Ashbourne; new edition; Houghton, Mifflin Co., Boston, 1915. May be obtained from Book Dept.; $1.30.

F. PERIODICALS

43. PROFESSIONAL MEMOIRS. Corps of Engineers, United States Army, and Engineer Department at Large; bi-

monthly (formerly quarterly); Washington Barracks, D. C., Engineer Press; per year, $3.

44. THE ROYAL ENGINEERS' JOURNAL. Royal Engineers' Institute, Chatham, England; monthly; per year, $4. (American agents: E. Steiger & Co., 49 Murray St., New York.)

45. JOURNAL OF THE MILITARY SERVICE INSTITUTION, Governors Island, New York. Bi-monthly; published by the Institution; per year, $3.

46. JOURNAL OF THE UNITED STATES ARTILLERY. Bi-monthly; Fort Monroe, Va., Coast Artillery School press; per year, $2.,75, including Index to Current Literature; without Index, $2.50.

47. JOURNAL OF THE UNITED STATES CAVALRY ASSOCIATION. Published by the Association at Fort Leavenworth, Kan.; per year, $2.50.

Standard Lock Washers for Machine Screws

The accompanying table gives the dimensions of lock washers adopted by the Society of Automobile Engineers.

STANDARD LOCK WASHERS FOR SMALL MACHINE SCREWS

	Screw — Diameters		Lock Washer				
				Section — Thickness			
No.	Maximum Body, In.	Fillister Head, In.	Inside Diameter, In.	Radial Width, In.	Light, In.	Heavy, In.	Counterbores Recommended, In.
4	0.112	31/64 (0.172)	(0.114)	1/32	0.022	1/32	3/16 (0.188)
6	0.138	7/32 (0.219)	9/64 (0.141)	3/64	1/32	3/64	1/4 (0.250)
8	0.164	37/64 (0.266)	21/64 (0.172)	3/64	1/32	3/64	9/32 (0.281)
10	0.190	5/16 (0.313)	25/64 (0.203)	1/16	3/64	1/16	11/32 (0.344)
12	0.216	11/32 (0.344)	7/32 (0.219)	1/16	3/64	1/16	3/8 (0.375)
14	0.24	25/64 (0.391)	1/4 (0.250)	5/64	1/16	5/64	7/16 (0.438)

It contains the dimensions of the machine screws by number, with the lock washer and size of counterbore recommended.

Building New Foundry Around an Old One Kept Working

A manufacturing concern in Canada, with a foundry 87 ft. long, 54.5 ft. wide and 17 ft. high to the top of the roof, got a war order that required the building of a new and larger foundry. The old foundry was running to capacity and could not be shut down till the new one was ready. The ground occupied by the old foundry and also to be utilized for a part of the new one.

To take care of all these conditions, the new foundry was designed with a length of 168 ft., a width of 73 ft. and a height of 18.5 ft. under the roof trusses. These dimensions permitted the new foundry to be built entirely around the old one, as shown in Fig. 1. In the meantime business goes on as usual in the old foundry. When the new foundry is complete, the work will be done in a part of it till the old one is taken down and removed.

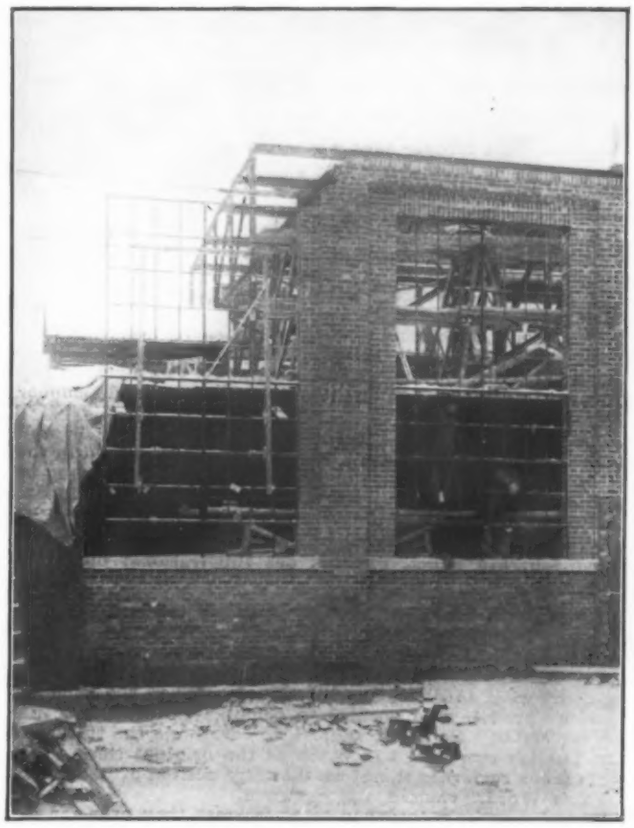


FIG. 2. JOINING UP THE NEW AND OLD WALLS

On the near side in Fig. 1 the new wall is outside the old one, but on the other side, shown in Fig. 2, the new and old walls are in line. The construction of the new wall, shown in Fig. 2, necessitates the removal of the old wall and a part of the roof, which is supported by shores.

FIG. 1. BUILDING A NEW FOUNDRY AROUND AN OLD ONE WITHOUT SUSPENSION OF WORK

NEW PUBLICATIONS

RUBBER MACHINERY—By Henry C. Pearson. Four hundred and thirteen pages, 9¼x6 in.; 428 illustrations. Published by the India Rubber World, New York City. Price, $6.

This book is divided into 20 chapters which consider in detail the following subjects: The washing of Crude Rubber, Crude-Rubber Drying, Dry-Sifting and Batching of Compound Ingredients, The Mixing, or Compounding, of Rubber, Preparing Fabrics for Calendering and Spreading, Calenders, Clutches, Drives and Safety Stop for Mills and Calenders, Molds—Metal and Rubber, Vulcanizers—General Types, Vulcanizing Presses—Screw and Hydraulic, Tube-Making Machinery, Spreaders, Doublers and Surface Finishers, Doubling Calenders, Cement and Solution Machinery, Extraction of Resin from Rubber and Gutta Percha, Reclaiming, Conveyors, Temperature Recording and Controlling Devices and Rubber Laboratory Equipment.

The volume deals with each subject in detail and is well supplied with illustrations. The various machines used in the rubber industry are shown; and as the operations of many of these machines are described, much valuable information to anyone interested in the industry is given.

ADVANCED MACHINE WORK—By Robert H. Smith. Third edition; 575 pages, 5x8 in.; 609 illustrations; numerous tables; indexed; cloth bound. Price, $3. Industrial Education Book Co., Boston, Mass.

The author, who is in charge of the instruction in shop-work at the Massachusetts Institute of Technology, originally published three books on machine-shop work. The first two dealt with the elements and principles of machine work and the third with advanced machine work. When the time for revision came, it was decided to combine the first two into one, under the title of the second, to rearrange the third and thus publish two books in place of the original three. The work under review is therefore the third edition of "Advanced Machine Work," revised and enlarged.

The changes are intended to fit it more than ever for the student, instructor, apprentice, machine operator and machinist who wish to obtain a thorough grasp of the fundamental principles that lie at the basis of successful machine-shop work. It is divided into twelve sections, with these headings: Lathe Work (sections 1 to 5 inclusive); Drilling Jigs, Boring Bars and Eccentric Turning; Cylindrical Grinding; Surface Grinding, Cutter Grinding; Planing; Milling; Gear Cutting; Tool Making.

Generous recognition is due the enormous amount of labor involved in preparing this book. Its compilation and use disprove the idea that machine-shop work should be taught differently from other engineering subjects. On the contrary, the logical arrangement of the matter shows that it can be taught from fundamental principles as well as any other. The book should be a decided help to anyone who wishes either to learn or to teach machine-shop work.

PURCHASING—By C. S. Rindsfoos. One hundred and sixty-five 6x9-in. pages; illus.; indexed. Price, $2. McGraw-Hill Book Co., New York. (Reviewed by Dexter S. Kimball, Professor Machine Design and Construction, Sibley College, Cornell University.)

As the author of this book points out, considerable attention has been given to the art of selling and considerable literature bearing on selling has appeared. It is somewhat curious that so little has been written on the art of buying, since purchasing and selling are necessarily coexistent. The volume under consideration is devoted to the more important problems and principles of purchasing with a discussion of methods for departmental organization.

The subject is presented in 10 chapters as follows: (1) How to Obtain the Right Article; (2) How to Obtain the Lowest Price; (3) How to Obtain Prompt Delivery; (4) Making the Purchase Conform to Fixed Policy; (5) How to Obtain Favorable Terms; (6) Personal Characteristics and Qualifications; (7) Strategy; (8) Some of the Legal Aspects of Purchasing; (9) Departmental Organization; (10) Forms.

A very useful and important feature of the book is the summary at the end of each chapter giving a brief resumé of the important discussions and conclusions found therein.

The first three chapters, as their titles indicate, are devoted to the general methods by which successful purchasing is conducted. Chapter 4 is a discussion of the advantages of a concern having definite general policies and of making the purchasing methods conform thereto. Chapter 5 is a discussion of what constitutes favorable terms and how to obtain them. Chapter 6 contains a good discussion of the personal qualifications that a purchasing agent should possess. Quite properly the author lays stress on broadmindedness and warns purchasing agents that, in common with other specialists, they tend to become narrow and to come to believe "that the business is conducted to purchase material."

Chapter 7, entitled Strategy, is very interesting, for in it the author endeavors to show how the emotions can be used to assist in getting good prices. While he condemns so called sharp practice, he also frankly states that it is difficult to draw the line at what constitute sharp practice. One is led to wonder whether, after all, buying and selling cannot be conducted on a higher plane and entirely free from such methods as this chapter discusses. Is it really true that it is "sometimes necessary to display anger—to show one's teeth"? Most certainly it is not good ethics to include "sleepers," that is, statements so hidden as to pass unnoticed, even though the practice is legal; and, as the author states, it will not pay in the long run. It is to be hoped that both buying and selling will soon be on a much higher plane than they are now. Petty graft, wine dinners, etc. have practically disappeared from commercial transactions, and there is reason to hope that the near future will see, more and more, buying and selling done on a basis of fact rather than as an old fashioned horse-trade. Nevertheless, this chapter is well worth reading if for no other purpose than to see what some of the practices indulged in are.

Chapter 8 is a simple and brief discussion of the elementary legal principles of purchasing. Chapter 9 treats rather too briefly of departmental organization. It contains a lengthy extract from the purchasing system proposed for New York City by Richmond Smith. While this is an interesting and helpful document, the reviewer cannot but feel that the space it occupies could be better filled by several illustrative examples of purchasing-department organizations.

I cannot agree with the author's ideas regarding inspection of material, so far at least as manufacturing plants in general are concerned. He states that in cases where the inspection and tests are under the engineering department "the purchasing department will furnish the engineering department with a copy of the order and specifications in order that the engineering department may know what it is entitled to demand." As a matter of fact, the engineering department will in most cases furnish the purchasing agent with specifications so that he will know what to buy. This short but important section could be rewritten to advantage.

The last chapter is devoted to forms of various kinds including blank forms for contracts, no forms appearing elsewhere in the book; the preceeding chapters being devoted entirely to the philosophy of the subject.

The book will amply repay reading. It contains much valuable information and many very helpful hints.

Memorial Tablet to George Westinghouse

The Veteran Employees Association of the Westinghouse Electric and Manufacturing Co. at its third annual banquet, held Saturday evening, Jan. 29, in the Fort Pitt Hotel, Pittsburgh, Penn., presented to the company a handsome bronze memorial tablet of the late George Westinghouse, founder of the numerous industries bearing his name.

The memorial tablet is approximately 4x3 ft., made of solid cast bronze and weighs about 300 lb. It shows a true bas-relief likeness of Mr. Westinghouse taken from one of his best photographic poses seated in an armchair. It bears the inscription "George Westinghouse, Master Workman, Inventor, Founder, Organizer, 1846-1914." It will be placed in the reception room of the East Pittsburgh works of the electric company.

"Financially Embarrassed"

A young man claiming to be associated with Sleeper & Hartley, Inc., Worcester, Mass., is reported to be operating the familiar bunco game. Under the plea of being temporarily embarrassed for one reason or another, a request for a loan is made.

The man is an impostor and in addition to a refusal should be handed over to the police.

PERSONALS

H. Schneider has been appointed general foreman of the H. G. Saal Manufacturing Co., Chicago, Ill.

S. J. O'Niel, formerly with O'Brien Bros., Chicago, Ill., has joined the selling organization of the Moller & Schumann Co., Brooklyn, N. Y.

B. F. Russler, until recently general foreman of the American Car and Ship Hardware Co., New Castle, Penn., has been appointed superintendent.

Louis Kruger, until recently master mechanic of the Hygienic Manufacturing Co., Chicago, Ill., has become president of the Ultra Manufacturing Co., Chicago, Ill.

John W. Hertzler, for several years Western representative of the Bearings Company of America, has been appointed assistant manager, with offices at the home plant in Lancaster, Penn.

Kristian A. Juthe has been made chief engineer of the Wheelock, Lovejoy Co., Cambridge, Mass. His brother, J. Charles Juthe, is now superintendent of the manufacturing department.

OBITUARY

Alexander Saunders, president of D. Saunder's Sons, Yonkers, N. Y., died at his home in that city on Feb. 1, aged 78 years.

Richard S. Bryant, factory manager of the Standard Welding Co., Cleveland, Ohio, died at the Post-Graduate Hospital in New York City, on Jan. 24. Mr. Bryant was a recognized figure in the automobile industry and was the first to design a quick-detachable rim. He was a native of Kansas and was only 46 years of age.

BUSINESS ITEMS

The Royersford Foundry and Machine Co. has built an additional warehouse and added two stories to its factory in Royersford, Penn.

The Vanadium-Alloys Steel Co., of Pittsburgh, whose works are at Latrobe, Penn., advise that they are installing an additional thirty-pot crucible furnace.

M. A. Palmer Co., 151 Franklin St., Boston, Mass., has recently been organized and is handling tool steel, forgings and die blocks, crucible and openhearth steels. M. A. Palmer is manager.

The Wagner Electric Manufacturing Co., St. Louis, Mo., announces the opening of a new office in the Mills Building, El Paso, Tex., with F. B. Hitchings as local manager. The new office is under the supervision of O. H. Davidson, district manager.

CATALOGS WANTED

The Crown Optical Co., Rochester, N. Y., would like to receive catalogs from manufacturers of machine-shop equipment.

The O'Brien Machinery Co., 107 North Third St., Philadelphia, Penn., want catalogs, price lists and jobbers' discounts on machine tools, steam and electrical equipment, woodworking machinery and supplies from manufacturers wanting representation in that territory.

TRADE CATALOGS

Providence Engineering Works, Providence, R. I. Circular. "Providence" shaper. Illustrated.

Arthur S. Brown Mfg. Co., Tilton, N. H. Catalog. Tilton endless belt. Illustrated, 8 pp., 6x9 in.

Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Catalog. Power hammers. Illustrated, 20 pp., 6x9 in.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet. "Proper Care of Belts." Illustrated, 24 pp., 3½x6 in.

Milliken Machine Works, West Newton, Mass. Folder. Ball turret heads, angle and bench plates. Illustrated.

The Standard Engineering Works, Pawtucket, R. I. Bulletin No. 11. Hand milling machine. Illustrated, 4 pp., 6x9 in.

Boston Gear Works, Norfolk Downs (Quincy), Mass. Catalog E9. Gears, racks, hobs, etc. Illustrated, 92 pp., 3½x6 in.

Wright Mfg. Co., Lisbon, Ohio. Catalog No. 7. Chain hoists, steel trolleys, hand cranes. Illustrated, 24 pp., 5x8 in.

Toledo Pipe Threading Machine Co., Toledo, Ohio. Catalog. Pipe threading and cutting devices. Illustrated, 72 pp., 4x7 in.

Diamond Clamp and Flask Co., Richmond, Ind. Catalog. Snap flasks, core machine, belt shifter, etc. Illustrated, 36 pp., 6x9 in.

Becker Milling Machine Co., Hyde Park, Boston, Mass. Catalog. Vertical and horizontal millers. Illustrated, 56 pp., 8½x11 in.

The Norma Co. of America, 1790 Broadway, New York. Catalog No. 105. "Norma" precision bearings. Illustrated, 124 pp., 6x9 in.

Newton Machine Tool Works, Inc., Philadelphia, Penn. Catalog No. 50. Rotary planing machines. Illustrated, 24 pp., 6x9 in.

Builders Iron Foundry, Providence, R. I. Catalog. Grinding and polishing machinery, "Pull" countershafts. Illustrated, 104 pp., 6x9 in.

Winter Bros. Co., Wrentham, Mass. Catalog No. 11. Carbon steel taps and dies, high-speed steel taps and dies. Illustrated, 122 pp., 5x7 in.

Millers Falls Co., Millers Falls, Mass. Catalog No. 35. Ratchet braces, hand drills, breast drills, lathe chucks, power hack saws, etc. Illustrated, 184 pp., 6x9 in.

The Watson-Stillman Co., 50 Church St., New York. Catalog No. 93. Sturcke-Watson-Stillman testing machine for cylindrical gas containers. Illustrated, 16 pp., 6x9 in.

Landis Machine Co., Inc., Waynesboro, Penn. Catalog No. 22. Bolt threading, bolt pointing, nut tapping, pipe threading and cutting machines, etc. Illustrated, 78 pp., 6x9 in.

The Richardson-Phenix Co., Milwaukee, Wis. Bulletin No. 50. Phenix force feed lubricators. Illustrated, 12 pp., 8½x11 in. Bulletin No. 60. Richardson Model M sight feed oil pump. Illustrated, 20 pp., 8½x11 in.

The Hydraulic Press Mfg. Co., Mount Gilead, Ohio. Bulletin No. 5004. "Heading Brass Cartridge Cases." 1,000-ton hydraulic press. Illustrated. Bulletin No. 5005. 800-ton hydraulic drawing press used for cupping and drawing Prest-O-Lite dissolved acetylene cylinders. Illustrated.

Niles-Bement-Pond Co., 111 Broadway, New York. Circular No. 101. 48-in. car-wheel borer. Illustrated. Circular No. 102. Center drive car wheel lathe. Illustrated. Circular No. 103. 36-44-in. side head boring mill. Illustrated. Circular No. 104. 90-in. driving-wheel lathe. Illustrated.

FORTHCOMING MEETINGS

A course of free lectures on military engineering will be given under the auspices of a committee representative of the four national engineering societies, by Captains Robins, Colner and Ardery, Corps of Engineers, U. S. A. This course will be under the direction of Major-Gen. Leonard Wood and is designed to assist those who desire to enter the engineering battalion which will be formed at Plattsburg next summer. All engineers interested in preparedness will be welcome, but attendance at these lectures does not imply obligation to subsequent camp duty. Through the cordial attitude and coöperation of the United Engineering Society, the auditorium of the Engineering Societies Building has been placed at the disposal of the army officers. These lectures will be given weekly, having begun on Feb. 14, under the following divisions:

Feb. 21, 1916—The service of reconnaissance, including surveying, mapping and sketching, photography and map reproduction.

Feb. 28, 1916—Field fortifications, sieges and demolitions.

March 6, 1916—Seacoast defenses and battlefield illuminations.

March 13, 1916—The construction, maintenance and repair of roads, bridges and ferries; the selection and preparation of fords.

March 20, 1916—The selection, laying out and preparation of camps and cantonments; the service of general construction; and the special services, including all public work of an engineering nature which may be required in a territory under military control.

March 27, 1916—The construction, operation and maintenance of railways under military control and the construction and operation of armored trains.

American Society of Mechanical Engineers. Monthly meeting first Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Wednesday each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. Secretary, R. H. Barnes, Taylor Instrument Companies, Rochester, N. Y.

Prices--Materials and Supplies

IRON AND STEEL

Pig Iron—Quotations were current as follows at the points and dates indicated:

	Feb. 10, 1916	Jan. 14, 1916	Feb. 11, 1915
No. 2 Southern foundry, Birmingham	$15.00	$15.00	$9.50
No. 2 X Northern foundry, New York	19.75	19.50	14.25
No. 2 Northern foundry, Chicago	18.50	18.50	13.00
Bessemer, Pittsburgh	2145	21.45	14.55
Basic, Pittsburgh	18.45	18.70	13.45
No. 2 X, Philadelphia	20.00	20.00	14.25
No. 2, Valley	18.25	18.50	13.00
No. 2 Southern, Cincinnati	17.90	17.90	12.40
Basic, Eastern Pennsylvania	19.50	19.50	13.50
Gray forge, Pittsburgh	18.45	18.45	13.45

Steel Shapes—The following base prices in cents per pound are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger from jobbers' warehouse, New York:

	Feb. 10, 1916	Jan. 14, 1916	Feb. 11, 1915
Steel angles, base	2.60	2.50	1.85
Steel T's, base	2.65	2.55	1.90
Machinery steel (bessemer)	2.60	2.50	1.80

Steel Sheets—The following are the prices in cents per pound from jobbers' warehouse, New York:

	Feb. 10, 1916	Jan. 14, 1916	Feb. 11, 1915
No. 28 black	3.50	3.35	2.60
No. 26 black	3.40	3.25	2.50
Nos. 22 and 24 black	3.35	3.20	2.45
Nos. 8 and 20 black	3.30	3.15	2.40
No. 16 black	3.45	3.15	2.35
No. 14 black	3.35	3.05	2.25
No. 12 black	3.30	3.00	2.20
No. 28 galvanized	5.50	5.50	3.65
No. 26 galvanized	5.20	5.20	3.35
No. 24 galvanized	5.05	5.05	3.20

Standard Pipe—On carload lots f.o.b. Pittsburgh, the discounts follow:

	Black		Galvanized	
	Feb. 10, 1916	Feb. 10, 1915	Feb. 10, 1916	Feb. 10, 1915
¾- to 2-in. steel butt welded	76%	81%	60½%	72½%
2½- to 6-in. steel lap welded	75%	80%	59½%	72½%

At these discounts, the net prices in cents per ft. follow:

Diameter, In.				
¾	2.76	2.20	4.54	3.15
1	4.08	3.24	6.72	4.67
1¼	5.44	4.38	9.09	6.30
1½	6.60	5.25	10.86	7.55
2	8.88	7.05	14.62	10.15
2¼	14.63	11.70	23.69	16.70
3	19.13	15.25	30.98	21.80
4	27.25	21.80	44.05	31.00
5	37.00	29.60	59.94	42.20
6	48.00	38.40	77.76	54.60

Swedish Drill Steel—The following prices are base in cents per pound to consumers f.o.b. warehouse, New York:

Carload lots and over	6.50
Over 10 tons, less than carload	7.00
Over 1 ton, less than 10	7.50
Over 500 lb., less than 1 ton	8.00
Less than 500 lb.	8.50
Hollow steel—	
Carload lots and over	10.50
Over 10 tons, less than carload	11.00
Over 1 ton, less than 10	12.00
Over 500 lb., less than 1 ton	13.00
Less than 500 lb.	14.00

Swedish Steel Sheets—To consumers requiring fair-size quantities tool steel sheets sell at 16c. base and spring steel sheets at 12c. base. These prices are f.o.b. warehouse, New York.

Bar Iron—Prices are as follows in cents per pound at the places named:

	Feb. 11, 1916	Jan. 13, 1916
Pittsburgh, mill	2.15	1.95@2.00
New York	2.25	2.10@2.15
From storehouse, New York	2.55	2.40@2.50

Swedish (Norway) Iron—This material sells at $4.50 base per 100 lb. f.o.b. New York. In coils an advance of 50c. is charged.

Cold Drawn Steel Shafting—From New York warehouse to consumers requiring fair-sized lots the price is 15% off list.

METALS

Miscellaneous Metals—The present New York quotations in cents per pound, with a comparison of practically a month and year ago, are as follows:

	Feb. 10, 1916	Jan. 14, 1916	Feb. 11, 1915
Copper, electrolytic (carload lots)	27.00	24.00	14.87½
Tin	41.25	41.00	35.87½
Lead	6.25	5.90	3.80
Spelter	19.50	17.62½	8.50
Copper sheets, base	33.00	30.00	19.75
Copper wire (carload lots)	33.00	30.00	15.50
Brass rods, base	38.00	35.00	16.50
Brass pipe, base	43.00	38.00	17.50
Brass sheets	38.00	35.00	16.75
Solder ½ and ½ (case lots)	26.00	25.75	24.50

ST. LOUIS

Lead ..... 6.10 Spelter 19.50

Old Metals—In New York, the following are the dealers' purchasing prices in cents per pound:

	Feb. 10, 1916	Feb. 5, 1915
Copper, heavy and crucible	21.50	12.10
Copper, heavy and wire	21.00	11.75
Copper, light and bottoms	18.00	10.50
Lead, heavy	5.00	3.20
Lead, tea	4.50	...
Brass, heavy	13.50	8.25
Brass, light	11.00	6.75
No. 1 yellow rod brass turnings	13.00	...
Zinc	12.50	4.50

Monel Metal—The following are the prices in cents per pound for mill lengths 8 ft. and over:

Size, In.	10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less Than 500 Lb. of a Size and Over
Rounds—Squares					
⅛ to ⅜	31.50	32.00	32.50	33.00	36.00
½ to ⅞	31.25	31.75	32.25	32.75	35.75
⅞ to 1⅞	31.00	31.50	32.00	32.50	35.50
1⅛ to 2⅞	31.75	32.25	32.75	33.25	36.25
Rounds					
3 to 3 7/16	32.50	33.00	33.50	36.00	37.00
Squares					
3	32.50	33.00	33.50	36.00	37.00
Rounds					
3½ to 3 15/16	32.25	32.75	33.25	35.75	36.75
Squares					
3 1/16 to 3 15/16	32.25	32.75	33.25	35.75	36.75
Rounds—Squares					
4 to 4 15/16	33.00	33.50	36.00	36.50	37.50
5 to 6 15/16	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ⅛ in. thick.

Hexagon bars 2c. per lb. over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

Babbitt Metal—In New York, quotations are as follows in cents per pound:

Best grade	55@60
Commercial grade	25@30

Antimony—For spot delivery on Chinese and Japanese brands the quotation is at 45c. per lb., duty paid.

SHOP ACCESSORIES

Turnbuckles—From New York warehouse, on sizes smaller than 1¼ in. diameter, 50% off list is charged, and on 1¼ up to 2 in. diameter 40%. At this rate prices follow:

Size		Size		Size	
⅜	$0.20	⅞	$0.38	1½	$0.90
7/16	.21	1	.44	1⅝	1.05
½	.23	1⅛	.50	1¾	1.20
⅝	.25	1¼	.75	1⅞	1.35
¾	.32	1⅜	.83	2	1.59

These prices are for buckles having right and left stub ends and with openings between the heads measuring 5½ in.

Nails—Wire nails f.o.b. Pittsburgh sell at $2.20; galvanized 1 in. and longer, $4.20, and shorter, $4.70. These prices are to regular customers and delivery is made at the mill's convenience.

Nuts—On hot pressed nuts $3 off list is allowed and on hexagon $3.20. At this rate the base price per 100 lb. for fair-sized orders from New York warehouse is as follows:

Hot Pressed Square Short Diam.	Blank	Tapped	Hot Pressed Hexagon Short Diam.	Blank	Tapped
½	....	$12.00	½	....	$17.70
9/16	$8.00	9.50	9/16	....	11.30
⅝	6.00	6.90	⅝	$6.40	7.40
⅞	5.00	5.70	1¼	5.20	5.80
1¼	4.50	4.90	1⅛, 1⅜, 1⅝, 2	5.10	5.70
1⅛, 1⅜, 1⅝, 2	4.40	4.80	2⅛	5.20	5.90
2⅛	4.50	5.00	2⅜	5.50	7.30
2⅜	4.80	5.40			

Semifinished nuts are sold at 70 % from list price.

On cold punched square nuts $3 from list is deducted and on hexagon $3.75. At this rate the base price on fair-sized orders from New York warehouse is as follows in cents per pound:

Bolt	Square Blank	Square Tapped	Hexagon Blank	Hexagon Tapped
¼	17.00	19.00	23.25	25.75
5/16	15.00	16.50	20.25	22.25
⅜	11.50	12.60	14.75	16.35
7/16	11.00	11.90	14.25	15.55
½	8.30	9.00	10.25	11.25
9/16	8.30	8.90	10.25	11.15
⅝	7.00	7.50	8.75	9.45
¾	6.70	7.10	7.65	8.25
⅞	6.60	7.00	7.35	7.95
1	6.60	7.00	7.35	7.95

The base price for fair-sized orders of case-hardened nuts from New York warehouse is 70% from list price.

Rivets—The following are the base quotations for fair quantities from New York warehouse:

	Discount from List
Steel 7/16 and smaller	65 and 10%
Tinned	65 and 10%

	Price per 100 Lb.
Button heads, ¾, ⅞, 1 in. diam. by 2 in. to 5 in.	$4.25
Cone heads, same sizes	4.35

	Extra per 100 Lb.
1⅛ to 1⅞ in. long, all diameters	$0.25
⅝ in. diameter	0.15
½ in. diameter	0.50
1 in. long and shorter	0.50
Longer than 5 in.	0.25
Less than kegs	0.50
Countersunk heads	0.50

Wrought Washers—From New York warehouse, the base price on fair-sized orders is $4.50 from list price. At this rate the following prices per 100 lb. hold:

Diameter, In.		Diameter, In.	
½	$9.50	1½	$4.80
¾	7.70	1¾	4.70
⅞	6.90	2	4.60
1	6.00	2¼, 2½, 2¾	4.50
1¼	5.30	3¼, 3, 3¼, 3½	5.00
1⅜	4.90	3, 3¼, 3½	4.70

For cast-iron washers, the base price is $2.50 per 100 lb.

Carriage Bolts—On ⅜ by 6 in. and smaller 60 and 5% off list is allowed; for larger and longer sizes 50 and 5% off list is charged. For fair-sized orders from New York warehouse the following net prices at this rate would be charged:

Length, In.	Diameter ¼	5/16	⅜	7/16	½	⅝	¾
1½	$0.38	$0.53	$0.72	$1.05	....	....	....
2	.41	.58	.78	1.14	....	....	....
2½	.46	.62	.84	1.24	$1.54	$2.73	$4.04
3	.49	.67	.90	1.33	1.68	2.91	4.28
3½	.53	.71	.97	1.43	1.81	3.09	4.51

Machine Bolts—From New York warehouse, the base price for fair quantities are as follows: From ⅜ in. by 4 in. and smaller, 60 and 10% off list is discounted; for larger and longer sizes up to 1 in. by 30 in., 50 and 10% is allowed. At this rate prices per 100 are as follows:

Length, In.	Diameter ¼	⅜	½	¾	⅞	1 In.
1	$0.61	$0.86	$2.34	$3.47	$4.73	$6.80
2	.64	.92	2.51	3.71	5.04	7.20
2½	.67	.98	2.68	3.96	5.36	7.61
3	.70	1.04	2.85	4.21	5.67	8.01
3½	.73	1.09	3.02	4.46	5.99	8.42

Base prices on other sizes would be as follows: 1⅛ and 1¼ in. by 3 in. and up to 12 in. take 40% off list. On longer lengths a special pound price is quoted. For cold punched square nuts, 40% is discounted from list; for hot pressed hexagon nuts up to 1 in. by 30 in., 50%; up to 1 in. diameter, cold punched nuts, 40%. Buttonhead with hexagon nuts, 40% off list, as do hexagon head with hexagon nuts.

Bolt Ends with hot pressed nuts sell at the base price of 50 and 10% from list price. This is for fair-sized orders from New York warehouse.

Coach or Lag Screws—Quotations from New York warehouse are unchanged at 65 and 10% from list. This is for fair-sized orders.

Tap Bolts—The discount from New York warehouse remains unchanged at 25% from list.

Copper Rivets from warehouse, New York, sell at 25 and 5% off list and burs at 2½ % the net list price.

MISCELLANEOUS

Welding Material (Swedish)—Prices are as follows in cents per pound f.o.b. New York:

Welding Wire		Cast-Iron Welding Rods	
3/8, 11/32, 5/16, ¼, 7/32, 3/16	8.50	¼ by 19 in. long	22.00
No. 8, 5/32 and No. 10	9.25	5/16 by 12 in. long	26.00
⅛	10.00	⅜ by 19 in. long	20.00
No. 12	11.00	½ by 21 in. long	20.00
7/64, No. 14 and 1/16	12.00		
No. 18	14.00	Vanadium Wire in Coils or Sticks	
No. 20	16.00		
Special Welding Steel		1/16	15.50
⅛	33.00	5/32	15.00
5/32	30.00	⅛	14.00
3/16	28.00	5/32	12.00
		3/16 and larger	11.00

These prices are subject to change according to quantity and shipment desired.

Seamless Drawn Tubing—The base price per pound from New York warehouse is 39c. for brass and 40c. for copper. For immediate stock shipment 3c. is added, which gives the following quotations:

Diameter, In.	Copper Feb. 10, 1916	Copper Feb. 11, 1915	Brass Feb. 10, 1916	Brass Feb. 11, 1915
¾ to 2½	43.00	21.50	41.00	17.00
3	43.00	22.00	41.00	18.00
3½	44.00	22.50	42.50	18.50
4	45.00	23.00	43.50	19.00
4½	47.00	24.00	45.50	20.00
5	49.00	25.00	47.50	21.00
6	50.00	28.00	48.50	24.00
7	52.00	30.00	50.50	26.00
8	54.10	32.00	52.60	28.00

Tin Plates—The following prices are in effect from warehouse, New York:

Coke tin plate, 14x20:

100-lb.	$4.45
I. C. 107-lb.	4.60

Terne plate, 20x28:

Base Weight	Net Weight	Coating	Price	Base Weight	Net Weight	Coating	Price
100-lb.	200	8	$8.30	I. C.	226	20	$13.50
I. C.	214	8	8.60	I. C.	231	25	14.25
I. X.	270	8	10.60	I. C.	236	30	15.50
I. C.	218	12	12.00	I. C.	241	35	17.00
I. C.	221	15	13.00	I. C.	246	40	19.00

Zinc Sheets—The following prices in cents per pound prevail at New York:

Carload lots, f.o.b. mill	24.00
In casks, New York	24.50
Broken lots, New York	25.00

Coke—The following are prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Jan. 22	Jan. 29	Feb. 5	Feb. 12
Prompt furnace	$3.00@3.25	$4.00@5.00	$3.00@3.25	$3.00@3.25
Prompt foundry	3.50@4.00	3.50@4.00	4.00@4.50	3.75@4.25

Sal Soda—These quotations are per 100 lb. at the places designated:

New York	$1.35
Philadelphia	1.10

Roll Sulphur in 360-lb. bbl. sells in New York at $2.25 per 100 lb.

Cotton Waste—In New York, the prices in cents per pound are as follows:

White	9.50@11.50
Colored mixed	6.50@ 9.00

Linseed Oil—Raw, in barrels sells at 77c. per gal. and in 5-gal. cans at 87c. Boiled, it is 1c. per gal. higher.

White Lead, dry and in oil, in cents per pound sells as follows:

100-lb. keg	8.75
25- and 50-lb. kegs	9.00
12½-lb. keg	9.25
1- to 5-lb. cans	10.75

Red Lead, dry, in cents per pound sells as follows:

100-lb. keg	8.75
25- and 50-lb. kegs	9.00
12½-lb. keg	9.25

In oil, the price in cents per pound is as follows:

100-lb. keg	9.25
25- and 50-lb. kegs	9.50
12½-lb. keg	9.75

New and Enlarged Shops

If you are in need of machinery or supplies, the first thing to do is to consult the Buying Section. If you cannot find just what you want, send us particulars, and we will be glad to publish it free of cost, thus putting you in touch with reliable manufacturers.

METAL WORKING

NEW ENGLAND STATES

Plans are being prepared by E. T. Stewart, Arch., 201 Devonshire St., Boston, Mass., for the construction of a garage at Belmont, Mass., for Henderson & Ross, 30 State St., Boston.

Bids are being received by S. S. Eisenberg, Arch., 45A Everett Ave., Chelsea, Mass., for the construction of a 3-story garage at Boston, Mass. Estimated cost, $40,000.

The contract has been awarded for the construction of a 2-story, 55x140-ft. garage at Brighton, Boston, Mass., for John D. Long. Estimated cost, $38,000.

E. F. Barney, care of F. W. Barlow, Jr., Arch., 80 North Main St., Brockton, Mass., will construct a 1-story garage. Estimated cost, $20,000.

The Colonial Realty Trust Co., Boston, Mass., has awarded the contract for the construction of a 2-story, 110x240-ft. garage at Medfield, Mass. Estimated cost, $100,000. Noted Feb. 3.

Bids have been received for the construction of a 4-story, 64x175-ft. garage for the Smith Carriage Co. on Park St., Springfield, Mass.

H. J. Hartnett plans to build a garage at Franklin and Vine St., Worcester, Mass. Estimated cost, $50,000.

The Woodlawn Screw Machine Co. has purchased the 2-story mill of the Seamless Wire Co. on Newell St., Pawtucket, R. I., and will install new machinery.

The Brown & Sharpe Manufacturing Co., manufacturer of machinery and tools, has awarded the contract for the construction of a 1-story addition to its factory No. 5 at Providence, R. I. Noted Feb. 10.

The Blue Ribbon Auto and Carriage Co. has awarded the contract for the construction of a 3-story, 63x98-ft. factory at Bridgeport, Conn. Noted Jan. 27.

The contract has been awarded for the construction of a 1-story, 110x300-ft. foundry at North Washington Ave. and Frederick St., Bridgeport, Conn., for the R. E. Parsons Foundry Co. Estimated cost, $35,000. Noted Jan. 27.

The New London Ship and Engine Co. plans to construct a plant at Groton, Conn.

The contract has been awarded for the construction of a 1-story, 48x68-ft. addition to the plant of the Risdon Tool Co. on Andrew Ave., Naugatuck, Conn. Noted Feb. 10.

Plans have been prepared by C. E. Joy, Arch., for the construction of a 2-story, 75x111-ft. factory on Commerce St., New Haven, Conn., for the United Smelting and Aluminum Co. Noted Sept. 23.

Bids are being received by the Standard Engineering Co., Center St., Waterbury, Conn., for a 1- and 2-story shop and garage.

MIDDLE ATLANTIC STATES

The American Body Co., Buffalo, N. Y., manufacturer of carriage and automobile bodies, will construct a 2-story factory at 1257 Niagara St. Estimated cost, $12,000.

Louis E. and Nathan Levy, 3287 3d Ave., New York, N. Y. (Borough of Bronx), will construct a garage. Estimated cost, $15,000.

Pennsylvania & Blake Corporation Realty Co., New York, N. Y. (Borough of Brooklyn), is having plans prepared by L. Schillinger, 167 Van Sicklen Ave., for the construction of a 50x100-ft. garage at Glenmore and Pennsylvania Ave.

Edward Schenk, 159 25th St., New York, N. Y. (Borough of Brooklyn), has had plans prepared by Shampan & Shampan, Arch., 772 Broadway, Brooklyn, for a 1-story shop and garage. Estimated cost, $12,000.

Plans being prepared by J. C. Cocker, Arch., 2017 5th Ave., New York, N. Y. (Borough of Manhattan), for the construction of a factory for the New York Central R.R. to be leased by Thomas F. Devine, 83 West End Ave., for the manufacture of automobile tops.

J. Bradley, 316 West 105th St., New York, N. Y. (Borough of Manhattan), is having plans prepared by E. H. James and A. W. Cordes, Archs., 124 West 45th St., for the construction of a 4-story garage. Estimated cost, $30,000.

The Tasker-Halstead Realty Co., 154 Nassau St., New York, N. Y. (Borough of Manhattan), will construct a 1½-story garage at Yonkers, N. Y.

The machinery and stock of the Standard Meter Co., 19th St. and 10th Ave., Watervleit, N. Y., will be offered at auction at 1 p.m., Feb. 24. Catalogs of tools may be obtained from Hiram H. Parke, Auctioneer, 2 East 23rd St., New York, N. Y.

The Pouvailsmith Corporation, Poughkeepsie, N. Y., recently incorporated with 2,500,000 capital stock, to manufacture all kinds of condensite products for automobiles, has awarded the contract for the construction of three 2-story factory buildings. Estimated cost, $100,000. E. C. Vail is interested. Noted Dec. 30.

The contract has been awarded for the construction of an addition to the plant of the International Arms and Fuse Co., Bloomfield, N. J. The new addition will be known as Building No. 4 and will cost $30,000. Noted Nov. 25.

The contract has been awarded for the construction of a 1-story addition to the plant of Kraeuter & Co., Newark, N. J., manufacturer of punches, chisels, etc. Estimated cost, $7,000. Noted Feb. 3.

Bids will soon be received by the Hutchinson Motor Co., Woodbury, N. J., for the construction of a 1-story, 50x105-ft. garage at Swedesboro, N. J.

Plans are being prepared by M. R. Evans, Arch., Lancaster, Penn., for the construction of 3 garages for David Rose, Lancaster.

Plans are being prepared by Bart Tourison, Arch., Land Title Bldg., Philadelphia, Penn., for the construction of 50 garages for John H. McClatchy, Wayne Ave. and Washington Lane.

The W. J. Gruhler Co. will construct a garage at 2234 George Lane, Philadelphia, Penn.

Newberry & Ferry, Wilkinsburg, Penn., are having plans prepared for the construction of a garage. B. F. Kreider, 1119 Pitt St., Arch.

The contract will soon be awarded for the construction of a garage at 27 South Charles St., Baltimore, Md., for the city. Estimated cost, $90,000.

The Maryland Metal Cross Tie Co., 627 Munsey Bldg., Baltimore, Md., will construct a foundry at Havre de Grace, Md.

SOUTHERN STATES

The Acme Garage, Martinsville, Va., recently incorporated, is in the market for equipment for a garage which it plans to establish. H. V. Price, Pres.

The Charleston Interurban Railroad Co., Charleston, W. Va., has awarded the contract for the construction of a 1-story addition to its factory.

Plans are being prepared by E. N. Alger, Arch., 608 Robson-Prichard Bldg., Huntington, W. Va., for the construction of a garage for C. W. Phellis, 1348 6th Ave.

J. E. Thompson, 633 5th Ave., Huntington, W. Va., has had plans prepared for the construction of a 2-story garage. Estimated cost, $10,000.

The Peninsular Iron Works, Lakeland, Fla., will construct several factory buildings. Estimated cost, $20,000. C. V. Turner is interested.

The Ford Automobile Co., Detroit, Mich., plans to construct an assembling plant at Birmingham, Ala.

The Gulf States Steel Co., Birmingham, Ala., has awarded the contract for the construction of a by-products plant at Gadsden, Ala. Estimated cost, $900,000. Noted Dec. 30.

The Southern Ry. has awarded the contract for the construction of repair shops at Knoxville, Tenn. W. H. Wells, Washington, D. C., Ch. Engr. Noted Feb. 10.

G. T. Harris, Morristown, Tenn., and K. T. Kenner, Rogersville, Tenn., plans to construct a garage at Morristown, Tenn. Estimated cost, $10,000.

The contract will soon be awarded for the construction of a garage at Covington, Ky., for the Charles Schiear Motor Car Co., Cincinnati, Ohio. G. Bernens, 124 East 8th St., Cincinnati, Ohio, Secy. and Treas.

MIDDLE WEST

The Timken Roller Bearing Co. has awarded the contract for the construction of a 2-story, 60x100-ft. addition to its plant at Canton, Ohio.

The Chisholm & Moore Manufacturing Co., manufacturer of malleable castings and chain hoists, Cleveland, Ohio, has awarded the contract for the construction of a 2-story addition to its plant at 5046 Lakeside Ave. Estimated cost, $10,000.

The Cleveland Motor Plow Co., recently incorporated with a capital of $600,000, will build a plant at Cleveland, Ohio., for the manufacture of motor-driven farm implements.

We have been advised that the Electric Railway Improvement Co., 2070 East 61st St., Cleveland, Ohio, will not construct an addition to its plant at Cleveland this year. Noted Jan. 27.

Plans have been prepared for the construction of a 70x105-ft. addition to the plant of the Loew Manufacturing Co., manufacturer of gas engines, etc., at 9100 Madison Ave., Cleveland, Ohio. Noted Feb. 3.

Plans are being prepared for the construction of a 5-story, 100x300-ft. addition to the plant of the Overland-Cleveland Co., 6604 Euclid Ave., Cleveland, Ohio. Estimated cost, $200,000. Noted Nov. 18.

The Superior Machine Tool Co. plans to construct a 70x200-ft. addition to its plant at Kokomo, Ind. Estimated cost, $50,000. A. L. Thalman is Pres.

We have been advised that the Portland Body Works, manufacturer of vehicle bodies and parts, has awarded the contract for the construction of an addition to its plant at Portland, Ind. Noted Feb. 3.

The contract has been awarded for the construction of an addition to the plant of the Portland Forge and Foundry Co. at Portland, Ind. Estimated cost, $20,000.

Bids has been received by J. G. Kastler, 524 Chamber of Commerce Bldg., Detroit, Mich., for the construction of a 2-story, 120x150-ft. foundry and shop for Anthony N. and John B. Lukomski, 2468 East Grand Blvd., Detroit.

The Motor Truck Body Co., 320 Franklin St., Detroit, Mich., is constructing a 1-story, 64x245-ft. factory at Detroit.

The J. N. Murray Manufacturing Co., manufacturer of auto parts, Detroit, Mich., has awarded the contract for the construction of an addition to its plant. Estimated cost, $10,000.

The Puritan Machine Co. has awarded the contract for the construction of a factory on Lafayette Blvd., Detroit, Mich.

Plans are being prepared for the construction of a 3-story, 100x158-ft. garage and factory at Detroit, Mich., for A. Wegner & Sons. Estimated cost, $50,000.

The H. M. Reynolds Roofing Co. plans to construct an addition to its factory at Godfrey Ave. and Pere Marquette R.R., Grand Rapids, Mich. Estimated cost, $8,500.

The Consolidated Engineering Co., Jackson Blvd. and Clinton St., Chicago, Ill., is constructing a machine shop at 2800 Shields Ave., Chicago. Estimated cost, $14,000.

We have been advised that the contract has been awarded for the construction of a 1-story, 75x120-ft. factory at Chicago, Ill., for the Cyclone Blow Pipe Co. Estimated cost, $25,000. Noted Feb. 3.

N. Landon Hoyt, Wilmette, Ill., will build a 4-story garage on East 21st St., Chicago, Ill. Estimated cost, $118,000. S. N. Crowler, 30 North La Salle St., Arch.

F. E. Kelley will construct a 1-story, 40x100-ft. garage at 628 North Green St., Chicago, Ill. Estimated cost, $10,000.

The contract has been awarded for 4521 Ogden Ave., Chicago, Ill., for Charles F. L'Hommedieu & Sons Co., 24 South Clinton St., Chicago, manufacturer of platers' supplies. Estimated cost, $22,000.

S. Linderoth & Co. plans to build a 1-story, 96x106-ft. garage at East 59th St. and Maryland Ave., Chicago, Ill. Estimated cost, $20,000.

Plans are being prepared for the construction of a 5-story garage at Chicago, Ill., for J. B. Murphy. Carl W. Westerling, 111 West Washington St., Chicago, is Arch.

The contract will soon be awarded for the construction of a 1-story, 40x50-ft. factory at Chicago, Ill., for the Planer & Sticker Bolt Supply Co., 4632 West Ohio St. Estimated cost, $10,000. Noted Jan. 27.

The Charles Stecher Co., Chicago, Ill., has purchased a factory at 1574 Crossing St., Chicago, and will be in the market for equipment for the manufacture of hand screw machines.

The contract will soon be awarded for the construction of an addition to the garage of the U. S. Auto Supply Co., 3845 South Wabash Ave., Chicago, Ill. Estimated cost, $12,000. A. L. Levy, 111 West Washington St., Arch.

The Wilson & Bennett Manufacturing Co., 58th St. and 65th Pl., Chicago, Ill., is in the market for steel barrel machinery.

The Ogren Motor Works will construct a plant at Waukegan, Ill. Estimated cost, $15,000.

Plans are being prepared by Edward Tough, 343 West Mifflin St., Madison, Wis., for the construction of a 3-story, 45 65-ft. garage at Pinckney and Doty St., Madison, for Edward Fisher, 8-9 Tenney Bldg.

N. C. Woodin and H. O. Hafemeister, Antigo, Wis., have organized a company to be known as the Hoist and Elevator Manufacturing Co. and will establish a plant at 2-4 Jackson St., Oshkosh, Wis., for the manufacture of contractors' hoisting machinery.

Loper & Loper has awarded the contract for the construction of a 2-story, 54x160-ft. garage and machine shop at Oshkosh, Wis. Estimated cost, $18,000. Noted Feb. 10.

John J. Feit will remodel building at Division and McCulloch St., Stevens Point, Wis., into a garage.

The Peninsula Automobile Co. will build a 50x130x50-ft. garage and machine shop at Cedar and Garland St., Sturgeon Bay, Wis.

The Kearney & Trecker Co., manufacturer of milling machines, will construct a 1-story, 60x250-ft. addition to its factory at West Allis, Wis.

WEST OF THE MISSISSIPPI

The Bettendorf Co., Bettendorf, Iowa, manufacturer of steel cars, contemplates adding 2 new furnaces to its foundry.

Press reports state that the Prusia Hardware Co., Ft. Dodge, Iowa, will rebuild its plant which was destroyed by fire. Estimated cost, $60,000. J. F. Nelson, Mgr. Noted Dec. 2.

The Chicago, Burlington & Quincy R.R., West Burlington, Iowa, will enlarge its shops. Estimated cost, $1,000,000. T. E. Calvert, Chicago, Ill., Ch. Engr. Noted Feb. 10.

Plans are being prepared for a 1-story reinforced-concrete plant for the Western Iron and Foundry Co. Wichita, Kan. Estimated cost, $4,000. Noted Feb. 10.

Plans are being prepared by F. A. Cole, Arch., 23 West Monroe St., Chicago, Ill., for a 2-story garage at Summitt and West Pennway St. for the American Express Co., Kansas City, Mo. Estimated cost, $50,000. J. S. Johnson, 1109 Grand Ave., Local Mgr.

The Koehring Machine Co., Dallas, Tex., recently organized, will construct a machine shop. George W. Smith is interested.

The plant of the Ft. Worth Boiler Works Ft. Worth, Tex., recently destroyed by fire with a loss of $15,000, will be rebuilt.

The Duff-McNew Foundry and Machine Co., Temple, Tex., will increase the capacity of its plant for the manufacture of disk-plow attachment for cultivators, stalk cutters and iron meter boxes.

The Western Tire and Garage Co., Texico, Tex., has been organized with a capital stock of $1,000,000 for the purpose of constructing a machine shop and garage. C. D. Robertson is interested.

Plans being prepared for a 2-story garage at 8th and Scott St., Wichita Falls, Tex., for C. W. Snider and J. J. Perkins.

WESTERN STATES

J. H. Flynn will build a garage and machine shop at 131 Lakeside Ave., Seattle, Wash. Estimated cost, $16,000.

The General Machinery Co. plans to build a plant on East Riverside Ave., Spokane, Wash., for the manufacture of mine accessories such as cages, ore cars, etc. E. J. Simos is Mgr.

The Pacific Coast Steel Co., San Francisco, Calif., contemplates the construction of a rolling mill at Portland, Ore.

The White Auto Co. will build a shop at Portland, Ore. Estimated cost, $24,000. MacNaughton & Raymond, Arch.

The Homer Laughlin Enginering Corporation, 2652 Long Beach Ave., Los Angeles, Calif., has increased its capital from $100,000 to $500,000 and plans to enlarge its plant at Los Angeles for the manufacture of drop forgings.

E. J. Swayne and A. H. Frost plans to build a 100x100-ft. garage and machine shop at 2nd and E St., San Diego, Calif. Estimated cost, $10,000.

CANADA

The Hamilton Gear Machine Co. has been granted a permit for the construction of an addition to its plant at Concord Ave. and Van Horne St., Toronto, Ont. Estimated cost, $4,500.

GENERAL MANUFACTURING

NEW ENGLAND STATES

The Goodall Worsted Co. will build a 1-story, 90x150-ft. addition to its mill at Sanford, Maine.

The Morley Button Co. will construct a plant at Portsmouth, N. H. Estimated cost, $100,000.

The Vacuum Fumigating Co. has awarded the contract for the construction of a plant at Boston, Mass. Estimated cost, $20,000.

The contract has been awarded for the construction of an addition to the plant of the Fisk Rubber Co., Chicopee, Mass. Estimated cost, $5,000.

The Elmwood Cleaning and Dyeing Co. contemplates the construction of a plant on Main St., Holyoke, Mass. Frank J. Hegy is interested.

The Converse Rubber Co., Pearl St., Malden, Mass., will construct a 4-story, 72x159-ft. addition to its plant. Estimated cost, $75,000.

The contract will soon be awarded for the construction of a 5-story, 40x56.8-ft. addition to the plant of Bickford & Sweet, manufacturer of slippers, at King St., Worcester, Mass.

The contract has been awarded for the construction of a 1-story, 60x78-ft. addition to the plant of Young Bros., manufacturer of paper boxes, at Eddy and Rhodes St., Providence, R. I.

Work will soon be started on the construction of a 2-story addition to the plant of the Clark O. N. T. Thread Co., Ansonia, Conn. Estimated cost, $200.000.

MIDDLE ATLANTIC STATES

The F .N. Burt Co., manufacturer of boxes and cartons, Buffalo, N. Y., plans to enlarge its factory at Niagara St., Potomac Ave. and the New York Central R.R. Estimated cost, $25,000.

The Danahy Packing Co., Buffalo, N. Y., will enlarge its cold-storage plant at Metcalfe and Clinton St. Estimated cost, $25,000.

Fire, Feb. 2, destroyed the canning factory of J. Whitham & Son, Middleport, N. Y. Loss, $21,000.

The Becker Aniline and Chemical Works, Ditmas Ave,. New York, N. Y. (Borough of Brooklyn), has awarded the contract for the construction of a 1-story, 80x93-ft. factory.

The Hayes Knitting Co., Oswego, N. Y., plans to build a mill at West 2d and Schuyler St.

The McLaren Knitting Co., West Sand Lake, N. Y., is building a 2-story addition to its plant.

The contract has been awarded for the reconstruction of the plant of the Farr & Bailey Manufacturing Co., manufacturer of linoleum and oil cloth, Camden, N. J., recently destroyed by fire. Estimated cost, $55,000. Noted Dec. 23.

The Harrison Chemical Co., Harrison, N. J., will build a plant for the manufacture of chemicals on the Newark Meadows.

The Celluloid Co., 290 Ferry St., Newark, N. J., has awarded the contract for the construction of an addition to its plant at 25 Magazine St. Estimated cost, $8,000.

The Samuel J. Aronsohn Silk Co., 448 East 18th St., Paterson, N. J., plans to construct a silk mill. Estimated cost, $40,000.

The Scott Paper Co. will construct a plant at Chester, Penn. Estimated cost, $250,000.

The plant of the Linenwear Hosiery Co., Clifton Heights, Penn., recently destroyed by fire, will be rebuilt.

The contract has been awarded for the construction of an addition to the plant of the Griswold Worsted Co., Darby, Penn. Noted Feb. 3.

Gibralter Hosiery Mills, Gibraltar, Penn., plans to build an addition to its factory.

The contract has been awarded for the construction of a 1-story, 50x55-ft. addition to the plant of C. F. Simonin's Sons, manufacturer of fertilizers, Tioga and Belgrade St., Philadelphia, Penn.

The Peerless Bleach Works, Philadelphia, Penn., has awarded the contract for the construction of a 2-story, 32x60-ft. factory at Unity and Elizabeth St.

The Roessel Silk Co., McKinley St., Philadelphia, Penn., will soon receive bids for the construction of a 2-story factory. Estimated cost, $10,000.

The contract has been awarded for the construction of a 2-story rug factory at Pittsburgh, Penn., for P. R. Geragocian, 309 South Highland Ave.

J. V. Poley, Arch., 162 2d Ave., Royersford, Penn., is preparing plans for a 2-story, 50x192-ft. mill at Spring City, Penn., for the Century Knitting Co.

The Artillery Fuse Co. will construct 3 factory buildings at Wilmington, Del. Estimated cost, $13,400.

The contract has been awarded for the construction of alterations and additions to the plant of the Baltimore Cold Storage Co., 117-23 East Pratt St., Baltimore, Md. Estimated cost, $40,000.

A 2-story, 52x86-ft. addition will be constructed to the plant of the Kingan Provision Co., 350-352 North Holliday St., Baltimore, Md.

The Maryland Cold Storage Co., Baltimore, Md., has awarded the contract for the construction of a cold-storage plant. Noted Nov. 11.

The American Metal Crosstie Co., Havre de Grace, Md., recently incorporated with $250,000 capital stock, will construct a 15,000 spindle mill for the manufacture of sea island cotton.

The Security Cement and Lime Co., Security Md., will construct a potash factory. Estimated cost, $50,000. John J. Porter, Mgr.

SOUTHERN STATES

The Caldwell Chemical Co., Spottsville, Ky., will build a plant at Sistersville, W. Va. Estimated cost, $100,000.

An addition will be built to St. Pauls Cotton Mill, St. Pauls, N. C., and new machinery installed.

The Shelby Hosiery Mills Co., recently incorporated with $25,000 capital stock, is establishing a cotton mill at Shelby, N. C.

The Thread Mills Co., Spray, N. C., has awarded the contract for the construction of a new mill. Estimated cost, $100,000.

The Hawthorn Spinning Co., Clover, S. C., is building a new cotton mill.

The American Potash Co. will construct a plant at Atlanta, Ga., for the manufacture of a fertilizer. Frank P. Cochran, Chicago, Ill., and E. M. Priest, New York, N. Y., are interested.

N. C. Doss, Rome, Ga., is interested in a project to construct a factory at Atlanta, Ga., for the manufacture of a new puncture-proof inner tube for tires.

The Cedartown Cotton and Export Co., Cedartown, Ga., will construct several additions to its plant and also install new equipment. Estimated cost, $125,000.

The Muscogee Manufacturing Co., Columbus, Ga., manufacturer of cotton goods, will expend about $350,000 for enlarging its plant. The company has secured a permit for the construction of a 5-story, 150x250-ft. building estimated to cost $90,000, which will be one of the first additions to be built.

The Russell Manufacturing Co., manufacturer of yarns, will construct an addition to its plant at Alexander City, Ala.

The contract has been awarded for the reconstruction of the plant of the Texas Oil Co., Birmingham, Ala. Estimated cost, $150,000. Noted Jan. 27.

According to press reports a tar-paper plant may be constructed at Gadsden, Ala.

J. F. Carter, Jr., Mobile, Ala., plans to establish a plant for the manufacture of woolen sweaters and sweater coats.

The Chamber of Commerce, Talladega, Ala., is organizing a company to construct a packing plant at Talladega.

J. W. Greer, Moultrie, Ga., is interested in a project to construct a packing plant at Tuscaloosa, Ala.

Frank P. Grace, Harrisburg, Ill., plans to establish a glove factory at Nashville, Tenn.

MIDDLE WEST

Plans have been prepared for the construction of an addition to the plant of the Highland Body Manufacturing Co., Elmwood Pl., Cincinnati, Ohio. The company is in the market for woodworking equipment.

The National Lead Co. has awarded the contract for the construction of a 1- and 2-story addition to its plant on Freeman Ave., Cincinnati, Ohio. Estimated cost, $35,000. Noted Feb. 3.

The Yardlet Screen and Weather Strip Co. will build an addition to its plant at Columbus, Ohio.

The Central Ohio Paper Co., 5th and Naghte St., Columbus, Ohio, awarded the contract for the construction of a 5-story plant on North 5th St., Columbus. Estimated cost, $200,000. Noted Jan. 20.

We have been advised that the contract has been awarded for the construction of a 2-story, 52x196-ft. and 42x115-ft. factory at Kent, Ohio, for the Mason Tire and Rubber Co. Estimated cost, $50,000. Noted Jan. 27.

The La Belle Box and Barrel Co., Martins Ferry, Ohio, has awarded the contract for the foundation of its new factory. The superstructure will be built by day labor. Estimated cost, $25,000. Noted Sept. 16 and Dec. 23.

Bids will soon be received for the construction of a plant at Kalamazoo, Mich., for the Riverview Coated Paper Co. Estimated cost, $400,000. Noted Dec. 30.

The American Bromine Co. will construct a plant at Midland, Mich. Walter N. White, Ingiewood, N. J., is Pres.

Plans are being prepared for the construction of a 3-story, 125x175-ft. factory at Chicago, Ill., for the Commercial Furniture Co., 2718 West Superior St., Chicago. Estimated cost, $60,000.

The contract has been awarded for the construction of a 3-story, 31x136-ft. factory at 4846-48 South Halsted St., Chicago, Ill., for Globe Mills. Estimated cost, $16,000.

The Smith Form-A Truck Co. will build a 176x362-ft. plant at Clearing, Ill.

Plans are being prepared for the construction of the superstructure of a 3-story, 50x100-ft. cold storager plant at Monticello, Wis., for E. Wittwer & Bros. Estimated cost, $25,000. Claude & Stark, Badger Annex, Madison, Arch.

WEST OF THE MISSISSIPPI

The Foot Schultze Co., Minneapolis, Minn., will build a shoe factory. Kees & Colburn, Donaldson Bldg., Minneapolis, is Arch.

The Marionville-Logan Cold Storage Association, Marionville, Mo., will build a cold storage plant. Estimated cost, $40,000.

The United States Aniline and Chemical Co., St. Louis, Mo., will construct a building at Laclede and Vandeventer Ave., for the manufacture of aniline dyes. Estimated cost, $50,000.

The Memphis Cotton Compress Co., Memphis, Tex., which was recently destroyed by fire, will rebuild its plant.

The Cuero Packing Co., Nixon, Tex., will build a packing plant at Nixon.

WESTERN STATES

The Filice & Perrilla Canning Co. will construct 3 additions to its plant at Gilroy, Calif.

Plans are being prepared by J. Schulz, Wright and Callender Bldg, Los Angeles, Calif., for the construction of a plant on Santa Fe Ave., Los Angeles, for the manufacture of boxes for the Southern California Box Co., 1335 East 6th St.

The Western Electro Chemical Co. is constructing a plant at Pittsburg, Calif. Estimated cost, $500,000. Mortimer Fleishacker, 2418 Pacific Ave., San Francisco, is interested.

The Sunset Canning Co. plans to improve its canning plant on East Bertie St., Pomona, Calif.

John Osborne, of the San Diego Fish Co., has leased a site at the foot of F St., San Diego, Calif., and plans to build a fish canning plant. Estimated cost, $25,000.

Swift & Co., Chicago, Ill., plans to construct a potash manufacturing plant on the water front near E St., San Diego, Calif. S. G. Smith is local representative.

The Coast Folding Paper Box Co., 560 Mission St., San Francisco, Calif., plans to enlarge its plant at San Francisco. J. Golinsky is Mgr.

CANADA

The Avon Hosiery Co. plans to build an addition to its factory at Stratford, Ont.

The plant of the Gold Medal Furniture Co. at Toronto, Ont., which was recently destroyed by fire, will be rebuilt.

The Dominion Canners Association, Hamilton, Ont., contemplates the construction of a plant at Vernon, B. C. D. Marshall is interested.

Classified Advertising

The Classified Advertising section appears on pages 159, 160, 161, of this issue and will in future appear in the same relative position in the paper.